MINING engineering

AUGUST 1960

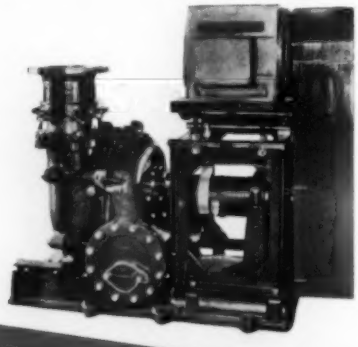
WILFLEY

SAND PUMPS

"True PUMPING ECONOMY Starts After You Buy a Pump!"

Price alone does not determine the actual value of a pump. Quality, efficiency, never-failing dependability . . . these are the prime factors a pump **must** have to give you **true** pumping economy. They pay off in low operating costs month after month, year after year.

WILFLEY SAND PUMPS guarantee true pumping economy through CONTINUOUS, MAINTENANCE-FREE SERVICE, LONGER PUMP LIFE, QUICK, EASY REPLACEMENT of PARTS, and MAINTAINED HIGH EFFICIENCY.



Wilfley Sand Pumps may be fitted with interchangeable electric furnace alloy iron, special application alloys or rubber-covered wear parts. Write, wire or phone for complete details.

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"Companions in Economical Operation"
Wilfley Acid Pumps

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Denver, Colorado, U.S.A. P.O. Box 2330
New York Office: 122 East 42nd Street, New York City 17, N.Y.

COMING EVENTS

Aug. 22-26, Western Resources Conf. sponsored by University of Colorado, Colorado State University, and Colorado School of Mines on "Water Measuring and Meeting Future Requirements," Lindsley Memorial Courtroom, Fleming Law Building, University of Colorado, Colo.

Sept. 8-9, SME Coal Div. and AIME St. Louis Section, joint meeting, Chase Park Plaza Hotel, St. Louis.

Sept. 12-16, Pan American Congress on Engineering Education, Buenos Aires, Argentina.

Sept. 12-18, International Mining Congress, sponsored by the Hungarian Mining & Metallurgical Soc., Budapest, Hungary.

Sept. 15-16, 8th annual Engineering Management Conference, sponsored by AIME, AIEE, AIChE, American Inst. of Industrial Engineers, ASCE, ASME, IRE, Morrison Hotel, Chicago.

Sept. 19-23, 7th Convention of Pan American Assn. of Engineering Socs., Buenos Aires, Argentina.

Sept. 24, AIME Adirondack Section, mine or mill tours through industrial minerals plant of Gouverneur Talc Co., Gouverneur, N. Y. Dinner at Gouverneur Country Club.

Sept. 27-Oct. 1, symposium on "Physics of Electrostatic Forces and Their Applications," Laboratoire d'Electrostatique et de Physique du Metal, Institut Fourier, Place du Doyen-Gosse. Grenoble, France.

Oct. 4-5, SME Board Meeting, Brown Palace Hotel, Denver; AIME Board Meeting, Denver Hilton Hotel, coinciding with SPE Fall Meeting.

Oct. 5, AIME Colorado Plateau Section meeting. Talk by AIME President Joseph L. Gillson.

Oct. 5-7, AIME Rocky Mountain Minerals Conference, Utah Section host, Newhouse Hotel, Salt Lake City.

Oct. 6-8, 9th National Clay Conference, Purdue University, Lafayette, Ind.

Oct. 7-8, Third Quinquennial Alumni Reunion of Minnesota School of Mines and Metallurgy. Open House and technical session, banquet-dance; Northwestern vs Minnesota football game, University of Minnesota, Minneapolis.

Oct. 10-13, American Mining Congress, Mining Show (metal mining-industrial minerals convention, exposition), Convention Center, Las Vegas, Nev.

Oct. 17-18, Symposium on Surface Mining Practices, College of Mines, University of Arizona, Tucson, Ariz.

Oct. 17-19, Drilling and Blasting Symposium, sponsored by Colorado School of Mines, Pennsylvania State University, and University of Minnesota, Colorado School of Mines, Golden, Colo.

Oct. 24-25, AIME-ASME Joint Solid Fuels Conference, Daniel Boone Hotel, Charleston, W. Va.

Nov. 4, AIME Pittsburgh Section, Off-the-Record meeting, Penn-Sheraton Hotel, Pittsburgh.

Nov. 7-10, Soc. of Exploration Geophysicists, annual international meeting, Galveston, Texas.

Nov. 15-16, Anthracite Conference, technical and scientific aspects of anthracite utilization, The Pennsylvania State University, University Park, Pa.

Nov. 18, American Mining Congress, coal division conference, Penn-Sheraton Hotel, Pittsburgh.

Dec. 3, AIME Colorado Plateau Section, technical meeting, election of officers, WAAIME dinner-dance, Grand Junction, Colo.

Dec. 5, AIME Arizona Section annual meeting, Pioneer Hotel, Tucson, Ariz.

Feb. 22-25, 1961, International Symposium on Mining Research, sponsored by U. S. Bureau of Mines and Missouri School of Mines and Metallurgy, Rolla, Mo.

Feb. 26-Mar. 2, AIME Annual Meeting, Chase Park Plaza Hotel, St. Louis.

Apr. 12-14, International Symposium on Agglomeration, sponsored by SME, SPE, and TMS of AIME, Hotel Sheraton, Philadelphia.

Sept. 17-20, Commemoration of the 50th Anniversary of Froth Flotation in the U.S.A., sponsored by AIME: Society of Mining Engineers' Mineral Beneficiation Division, Cosmopolitan Hotel, Denver.

MINING engineering

VOL. 12 NO. 8 AUGUST 1960

COVER *Artist Herb Mc Clure this month portrays one of the men behind the growing mineral strength of Communist China. K. C. Wang, Far East Specialist of the U.S. Bureau of Mines presents a detailed analysis of the mineral potential that lies behind the "bamboo curtain" in the article beginning on page 901.*

REPORT ON RED CHINA

901 **Mineral Wealth and Industrial Power—Communist China's Boasts Begin to Come True**
• *K. P. Wang*

ARTICLES

913 **Development of a Thermoadhesive Method for Dry Separation of Minerals**
• *R. J. Brison and O. F. Tangel*

918 **Beneficiation of Rock Salt at the Detroit Mine**
• *W. C. Bleimeister and R. J. Brison*

922 **New Facilities Accelerate Chile's Iron Ore Exports**

925 **U.S. Strategic Materials Stockpiles and National Strategy**
• *John D. Morgan*

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MINING ENGINEERING staff, Society of Mining Engineers, and AIME Officers are listed on the *Drift* page.

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PERSONNEL

THESE items are listings of the Engineering Societies Personnel Service Inc. This Service, which cooperates with the national societies of Chemical; Civil; Electrical; Mechanical; Mining, Metallurgical, Petroleum Engineers, is available to all engineers, members and nonmembers, and is operated on a nonprofit basis. If you are interested in any of these listings, and are not registered, you may apply by letter or resume and mail to the office nearest your place of residence, with the understanding that should you secure a position as a result of these listings you will pay the regular employment fee of 60 pct of the first month's salary if a nonmember, or 50 pct if a member. Also, that you will agree to sign our placement fee agreement which will be mailed to you immediately, by our office, after receiving your application. In sending applications be sure to list the key and job number. When making application for a position, include 8¢ in stamps for forwarding application to the employer and for returning when possible. A weekly bulletin of engineering positions open is available at a subscription rate of $3.50 per quarter or $12 per annum for members, $4.50 per quarter or $14 per annum for nonmembers, payable in advance. Local offices of the Personnel Service are at 8 W. 40 St., **New York 18;** 57 Post St., **San Francisco;** 29 E. Madison St., **Chicago 1.**

In addition to the listings below, ESPS maintains a more complete file of general engineering positions and men available. Contact nearest ESPS office, listed above. The New York office of ESPS will be open Thursdays until 7:00 P.M. for interviews.

MEN AVAILABLE

Production-Operations Manager, B.S. in chemical engineering. Over 17 years production management, engineering, development, in chemical process industries. Location immaterial. M-553.

Geologist-Petrographer, M.S. from an eastern university. Two years experience petrographic identification of rock types and mineral fragments utilizing the powder immersion method. Desires position as petrographer or mineralogist. M-554.

Mining Engineer, degree in mining engineering, age 31. Four years experience mining, exploration, underground and surface surveys in iron ore and bauxite mines; one-half year teaching mining. Prefer Great Lakes or Northwest. M-555.

Chemical engineer, graduate. Experienced inorganic chemicals and nonferrous extractive metallurgy. Age 48. Prefer New York metropolitan area but will consider any location. M-556.

Mine Superintendent, mining engineer, 29. Five years in charge production, ore control, pit plan and development, survey for open pit mining. Military completed. $8400. Prefer western U. S. Home: Arizona. Se-1660.

Superintendent, mining engineer, 40. Ten years in charge production, maintenance, mining for zinc mining and smelter. One year in charge of open pit gold, copper mine. Two years office, field, exploration of lead, zinc, copper properties. $10,500. Prefer West. Home: Pennsylvania. Se-1896.

Geologist, M.A. in geology, 31. Exploration experience, local and foreign, for major oil companies; engineering geology, subsurface foundation investigation, research. Speak Arabic, French, Spanish. $7200. Prefer California, Near East, Latin America. Home: Ohio. Se-1760.

Mine Engineer, degree in mining engineering, 30. Four years experience layout, plan future mining operation, design cost estimate on mining operation. $7200. Prefer West, North. Se-155.

Mine Manager, Geologist, mining engineer, 42, licensed in Arizona. Twenty years experience as consultant, superintendent in charge of all phases of mining, geology, operation, ore dressing, leaching, all metals, nonmetals, including design operation, exploration, mill design. $9000. Prefer South America. Home: Arizona. Se-152.

Geologist, degree in geology, 27. Two years experience compiling geological maps, ground water geology, evaluation and location of mines and mining claims for the government and mining companies. $5400. Any location. Home: Utah. Se-100.

Geologist, degree in geology, 37. Four years experience in petroleum geophysics and logging. Four years mining experience underground and open pit. Supervisor of underground mining operation. Two years extensive mine property examination and evaluation. Directed exploration program in South America. $6600. Prefer Northwest or foreign. Home: Idaho. Se-491.

Geologist, Production, degree in geology, 35. Broad academic background in economic geology and petrology. Five years underground diesel mechanized metal mining experience as geologist then mine operator. Supervisory, production, and administration experience. Three years in quarry blasting, supervision. Current with latest techniques using low cost blasting agents. Salary open. Prefer U. S. Home: Northwest. Se-486.

Construction Engineer, mining engineer, 38. Supervisory and administrative ability in mining and mine construction. Dealt with equipment maintenance, safety, contracts, construction plans, geology, survey, diamond drill exploration, supplies, purchasing, developing, and mining layout. $6600. Prefer San Francisco. Home: California. Se-464.

Mining Engineer, Geologist, degrees in mining and metallurgy, 58. Twenty-six-years experience in mine exploration and examination, survey, planetable, transit, and mapping of mineral resources for the government. Salary open. Prefer San Francisco bay area, Arizona. Home: California. Se-265.

POSITIONS OPEN

Mining Engineer, graduate, with five to ten years experience in diamond mining for large diamond mine in French Equatorial Africa. Salary open. F9255.

Ore Grader for production engineering and quality control department. Degree in mining or geology, with minimum of three to five years experience, to advise regarding location of producing shovels in mine to maintain established chemical and physical ore grade figure; direct ore sampling and billing crews to maintain quality control; to advise regarding proper dumping sequence of loaded ore cars, stocking of ore, reclamation of ore and sampling of ore cargoes. Working knowledge of Spanish desirable. Salary, $10,200 to $13,800 year. Location, South America. F9170.

Mine Manager with at least ten years supervisory experience for extensive gold and platinum placer operation in jungle territory. Salary, $10,000 year with food. Location, South America. F9151.

Mineral Dressing Engineer for research and process development in industrial mineral fields. Salary, $5400 to $7200 year with liberal vacation, retirement, and other benefits. Location, Southeast. W9832.

Design Engineer. Castings. Degree in mining and or metallurgical, or mechanical engineering preferred, with considerable experience as a process or design engineer, preferably in mining or casting field, for the design of castings of manganese and other wear-resistant steel alloys. Salary to start, $10,000 year. Location, Illinois. W8928(a).

Assistant Vice President, Operations, for a large multiplant producer of chemicals and minerals, to 45, engineering background in related industry. Will report to and assist vice president in overall direction and coordination of a number of widely dispersed physical plants engaged in mining and processing inorganic chemicals. Will handle full range of administrative problems with line responsibility. Excellent opportunity. Salary, $20,000 to $30,000 year plus additional benefits. Location, Chicago. W8876.

Mining Engineer, graduate, with knowledge of manganese mining, geology, and methods for its beneficiation, also knowledge of gravity concentration methods. Knowledge of zinc, lead, and graphite mining and metallurgy would be of value. Will be responsible for field work in developing sources of supply of raw materials and adapting such materials to commercial use. Some traveling to Central and South America; base operations in Wisconsin. Salary, $7,500 to $10,000. Employer will pay placement fee. C-8155.

(Continued on page 872)

ENGINEERS

Mechanical, Chemical and Extractive Metallurgical engineers with outstanding qualifications to fill production, development and engineering positions in processing plants located at Rifle and Uravan, Colorado. Send resume and copy of college transcript to:

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Excellent opportunity for versatile young engineer to obtain broad experience in research and process development on many industrial minerals. Salary $5400 to $7200 with liberal vacation, retirement, insurance and other benefits. Send resume with emphasis on mineral beneficiation background to :

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KW-DART SHOWS 35SL

Model 35SL

KW-DART Truck Co., Kansas City, Mo., steals the show with the first single axle, 35 ton, rear end dump truck. Powered by a 400 H.P. engine, 3-stage converter and 3-speed transmission, this new KW-DART promises to be a revolutionary step forward in mining and construction operations. It's rugged with KW-DART'S 110,000 pound planetary drive axle and 50,000 pound tubular front axle. Gross vehicle weight is 131,600 pounds. Superintendents enthusiastic!

1958!

EXTRA MINING CONGRESS CONVENTION

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Model 50T

This year KW-DART shows the new model 50T—a sensational new 50 ton, 600 H.P. truck with tandem rear planetary axles of 100,000 lb. capacity each. This truck will provide power for the climb and speed for the haul road with 3-stage converter and 4-speed transmission and 50,000 pound capacity front axle. Gross vehicle weight is 188,000 pounds.

What will KW-DART show at the Mining Congress Convention in 1960?

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CONFIDENTIAL UNTIL OCT. 1960

at Las Vegas MINING CONGRESS CONVENTION

IN THE MAIN ARENA

As in past years, KW-DART is introducing a revolutionary new haulage concept in the mining industry. The new KW-DART being shown is a new [illegible], single [illegible] with more H[illegible] than ever used before. [illegible] tractor [illegible] combination, it has [illegible] biggest payload ca[illegible] —carrying [illegible] tons [illegible]

KW-DART® TRUCK CO.

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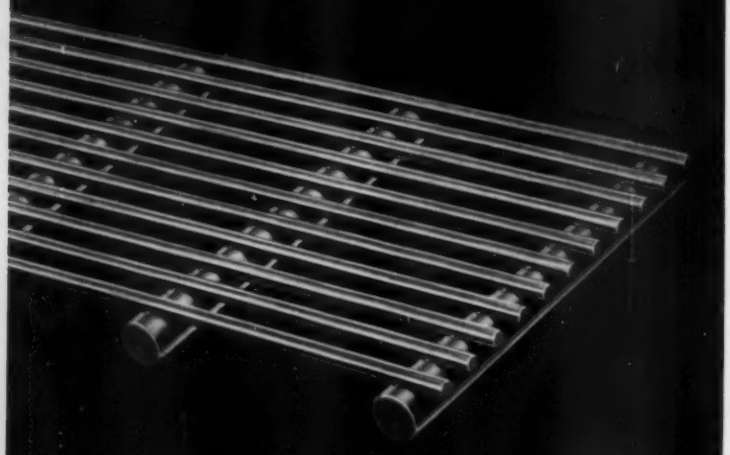

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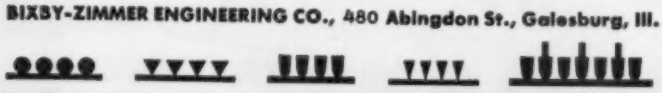

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PERSONNEL

(Continued from page 870)

Chief Engineer, mining engineering or civil engineering degree required, under 45. Complete charge of all engineering functions and personnel. Department responsible for underground and open pit mapping; underground measurements for contracts; planning, design, layout and construction supervision of structures and equipment for underground and open pit mines and three metallurgical plants, and generally related functions. For producer of phosphate rock in western U. S. Salary, $9000 to start; excellent opportunity for rapid increase. Sj-5382.

Geologist, mining engineering or geological engineering, or equivalent. Five to eight years experience in geology work preferably with mining company; to do geological investigations, surveying and mapping of solid materials formation—both metals and nonmetals, evaluate mineral resources of all types and report. About $6600 or more, depending on experience, plus expense; willing to work in remote western areas. Single or limited family status. One year duration. Sj-5381.

General Superintendent, competent man, analytical in engineering, physically fit, and speaking knowledge of Spanish necessary. For 50 tpd Pb-Zn-Ag operation, 150 Spanish-speaking men. Minimum $6600 plus furnished house, fuel, and electricity. Single status required for four to six months, 5000 ft, climate pleasant and healthful. Two-year contract. Central America. Sj-5348.

Geologist and Mine Engineer, graduate, age open. Should be able to perform with minimum supervision in making mine surveys and assisting in mine management work. For a 240-tpd Cu-Zn underground mining operation and flotation mill. For a mining company. Housing and school available. About $7200. Arizona. Sj-5329.

Assistant Geophysicist, recent graduate, some geophysical experience in layout work, interpreting results and calculating for metals geophysical purposes in large prescribed areas. Knowledge of use and application of instrument and test devices. Work involves general area investigation for mineral-bearing formations. To assist senior geophysicist. Required to move from place to place every three or four months. About $6000 to $6600, depending on experience and training plus living expenses. Nevada and western Utah. Headquarters, San Francisco. Sj-5323.

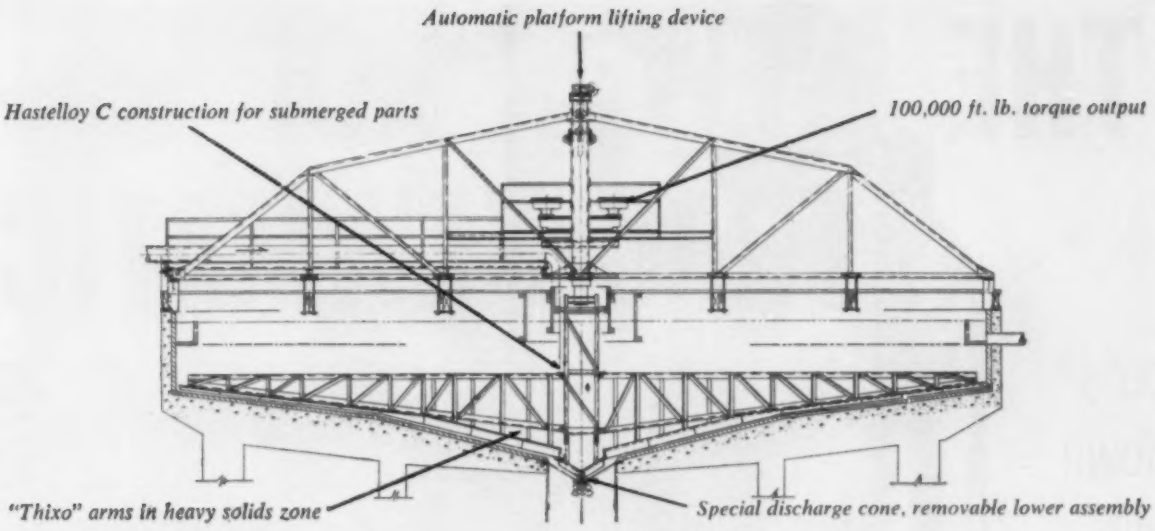
Pilot Plant Superintendent, metallurgical engineering or mining engineering degree, 30 to 45. Experienced in pilot plant ore dressing operation (heavy media, jigging, spirals, flotation, magnetic separation) for iron ore operation. Working knowledge of Spanish desirable. Possibly family housing after employment after two or three months single status. For an open plant mine operation. About $9000 plus benefits. South America. Sj-5210.

Development Engineer, graduate, some experience desirable. For development work in area of explosives and propellants. Salary open. Southwest. For a chemical company. Sj-5289.

Mine and Mill Superintendent, degree in mining engineering, 55 to 60. Field man in charge of mine and mill, experienced in underground gold mining. Must speak Spanish and be able to take charge of maintenance, repair of diesel engine equipment, mining, milling operations as work superintendent or field manager for 50-tpd underground gold mine. In very remote area, will have to go single status first, then bring family. $9000 plus room and board. At least one year's work, may be permanent. Mexico (5000 ft elevation). Sj-5263.

Mine Engineers, graduates and some experience either in underground nonmetallics or deep coal mining. For production planning, cost forecasting, layout of mining systems, design of installations such as conveyors, shafts, raises, etc., and also routine mine operating problems. For mine engineering staff of 11. 14,000 tpd. Salary open. Southwest. Sj-5260.

Mining Geologist, graduate, 28 to 35, about five years experience, for general geological duties applicable to operating mine involving underground geological mapping, surveying, stope mapping, and assisting engineering department. Salary open. Colorado. Sj-5249.


Automatic platform lifting device
Hastelloy C construction for submerged parts
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"Thixo" arms in heavy solids zone
Special discharge cone, removable lower assembly

Unique Thickener Features Solve Difficult Recovery Problem at Freeport Nickel Co.

For difficult thickening conditions, it would be hard to beat those in the sulphide circuit at Freeport Nickel Company's Moa Bay extraction plant in Cuba. Consider these built-in problems:

. . . a feed of precipitated cobalt and nickel sulphides in a dilute sulphuric acid solution containing hydrogen sulphide gas.

. . . a process temperature of 190°F.

. . . 5.16 specific gravity solids that settle rapidly to 70%, at which density they are very difficult to pump.

. . . a need to clarify and recover the overflow.

The acid brick lined tanks at Moa Bay are above ground level for easy access to discharge cones. Wooden covers confine hydrogen sulfide gases.

These unusual conditions obviously required an unusual solution, and close work between the Freeport engineers, C. F. Braun & Co. engineers and Eimco-Process resulted in two thickeners with unique features specifically designed to recover the valuable sulphides.

To resist corrosion, and because of the elevated temperature, all submerged parts were constructed of Hastelloy C. To permit raking the heavy solids at close to the 70% concentration limit while clarifying the overflow, 100,000 ft. lb. torque output driveheads were used instead of the standard 36,000 ft. lb. torque usually provided for 60 ft. tanks. Platform lifting devices, controlled by torque transmitters, were designed to automatically raise and lower the entire raking mechanisms in the pulp to compensate for varying loads.

In the inner 30 ft. dia. of the tank bottoms, Eimco-Process "Thixo" arms were used so that the lower chords of the raking trusses would be above the heaviest pulp. Finally, to ensure efficient underflow withdrawal, special discharge cones with removable lower assemblies were devised. These connect to rubber hose underflow lines and are fitted with high-pressure water connections for quick unplugging.

This unique installation is just another example of Process Engineers' willingness and ability to design for special applications. But whether your problem requires a standard or special thickener mechanism, we would like to work with you. Please contact any of our sales offices . . . they're worldwide.

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Here's Le Roi's brand-new, hard-working crawler drill — The Trac-Newmatic.

The Trac-Newmatic carries a big 5-inch drifter on an extra-sturdy air-powered feed shell . . . all mounted on a hard-lugging crawler that can pull a 600 rotary along with it over tough terrain.

The 5-inch drifter features a striking-bar design that efficiently squeezes every ounce of power out of the available air . . . minimizes leakage and blow-by . . . drills 4-inch hole fast. What's more, the drifter has forward, neutral, and reverse rotation to assure fast driving, easy extracting, and speedy steel-uncoupling or coupling.

An air-motor driven hydraulic pump is used to quickly position the feed shell for breast- or lift-hole drilling either straight ahead or over the tracks to give a wide drilling pattern from a single location. A standard model with hand-operated hydraulic pump to raise and lower the boom is also available.

Tramming is easy, too . . . two hefty 7½ hp reversible air motors give the Trac-Newmatic plenty of power, while the oscillating tracks permit tramming or parking even on irregular terrain. Controls are mounted for both convenient operation and good visibility, and a "deadman" feature anchors the unit in place when the tramming levers are released.

See the Trac-Newmatics at your Le Roi distributor—or write us for more detailed information. Le Roi Division, Westinghouse Air Brake Co., Milwaukee 1, Wis.

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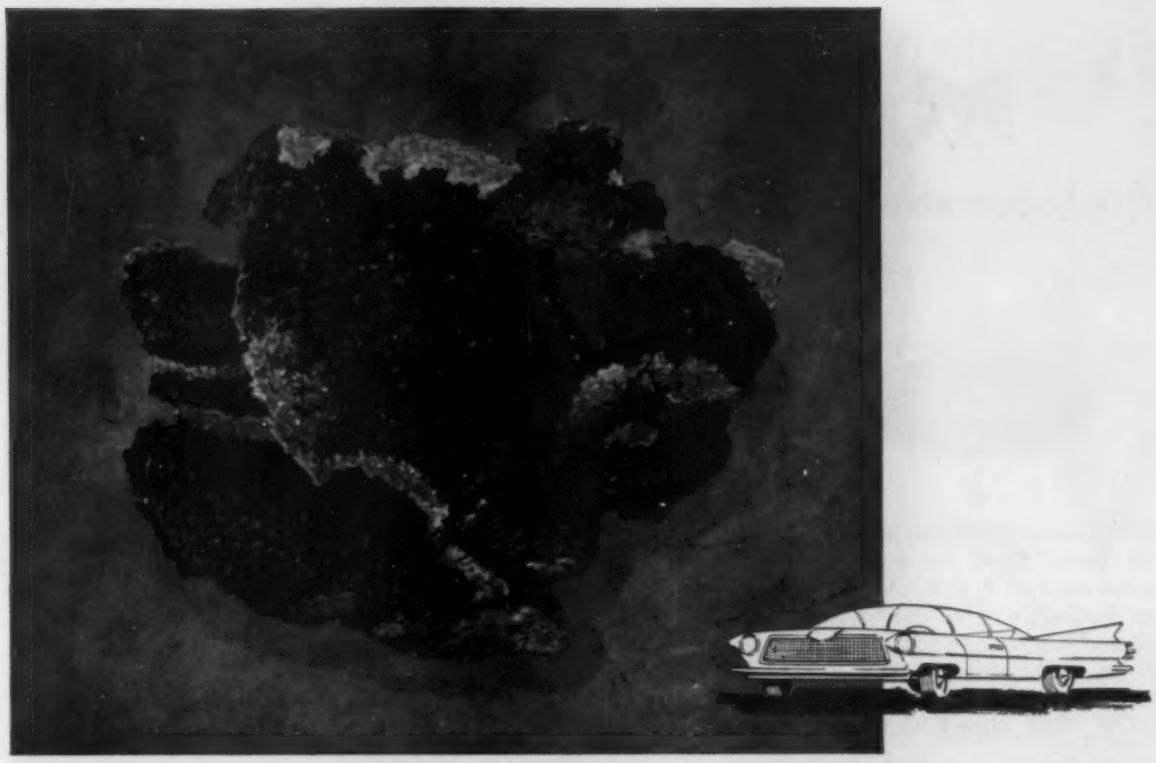
PORTABLE AND TRACTAIR® COMPRESSORS • STATIONARY COMPRESSORS • AIR TOOLS



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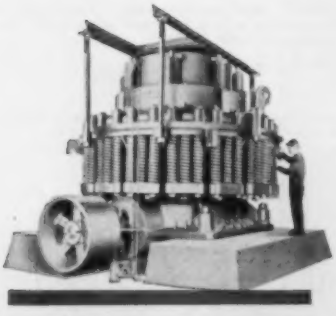
the "deceitful" ore of useful and ornamental ZINC

Zinc, from the ore *sphalerite*, is a metal of great economic importance. In the automotive industry alone, the increasing decorative and functional use of zinc die castings for grilles, instrument cluster housings, dash panel bases, door handles, etc., demonstrate the ore's economic value. It has long been used for galvanizing, brass making, and zinc-white pigments.

From earliest times, sphalerite has been known as the "treacherous" or "deceiving" ore. There is no other mineral whose appearance varies so much and which is so difficult to recognize on sight. It resembles galena but yields no lead. It is often host of many rare elements such as gallium or cadmium as well as many common minerals. Black sphalerite may contain as much as 18% iron.

This "deceitful" mineral and other zinc ores are efficiently and economically reduced by Symons Cone Crushers to the fine, uniform size necessary for further processing. As in all important ore and mineral operations throughout the world, Symons Cone Crushers are first choice of leading producers for high capacity production at low cost.



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Mineral Information

An International Directory of Engineering Source Material

BOOKS

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Electrochemical Engineering by C. L. Mantell, fourth edition, *McGraw-Hill Book Co. Inc.*, 680 pp., $16.50, 1960.—Reflecting the tremendous advances in electrochemical practice since 1950, this edition emphasizes industrial processes, with adequate grounding in fundamental theory, which is given a rigorous thermodynamic treatment in the new first section. The final chapters deal with the electrochemical theory of corrosion, cathodic protection, and engineering aspects. Technical, statistical, and operating data gathered in the field are included throughout. • • •

Seaman's Mineral Tables by Kiril Spiroff, *The Michigan College of Mining & Technology Press*, Houghton, Mich., 82 pp., $2, 1960.—A completely revised and up-dated guide to mineral identification for use by both amateur and professional geologists and mineralogists. The first edition was published in 1934 in pocket size. This new edition is spiral bound, size 8½x11 in., providing adequate space for the user to add notes or sketches of his own. • • •

The Physical Chemistry of Metallic Solutions and Intermetallic Compounds, *Chemical Publishing Co. Inc.*, 212 Fifth Ave., New York 10, N.Y., Vol. I, 434 pp., $8.50; Vol. II, 310, $8.50, 1960.—A symposium by the foremost scientists of the world on every phase of the subject. It consists of some 50 collected papers by citizens of 14 different countries. Volume I covers experimental methods used with metallic systems, metallic solutions and intermetallic compounds. Volume II includes phase transformations, practical applications of thermodynamics and phase diagrams, gas metal and slag-metal reactions, and nonstoichiometry in metal compounds. • • •

International Strata Control Congress, *Helios Literatur-Vertriebs-GMBH*, Eichborndamm 141-167, Berlin-Borsigwalde, Germany, 319 pp., $17.50, 1960.—A report of the Congress held in Leipzig, October 1958, dealing with the problems of rock pressure as they affect safety arrangements in underground workings. • • •

Proceedings of the Symposium on the Development of Petroleum Resources of Asia and the Far East, Mineral Resources Development Series No. 10, *United Nations*, order from International Documents Service, Columbia University Press, 2960 Broadway, New York 27, N.Y., 266 pp., $2.50, 1959.—This publication contains the report and the principal documents of the Symposium held in New Delhi in December 1958 under the sponsorship of the United Nations Economic Commission for Asia and the Far East. • • •

Annex to the Proceedings of the Symposium on the Development of Petroleum Resources of Asia and the Far East, Mineral Resources Development Series No. 10 (Annex). Order from *International Documents Service*, Columbia University Press, 2960 Broadway, New York 27, N.Y., 80 pp., $1, 1959.—This publication contains 72 figures for the documents included in the above-mentioned title. • • •

Mining Developments in Asia and the Far East 1957, Mineral Resources Development Series No. 11. Order from *International Documents Service*, Columbia University Press, 2960 Broadway, New York 27, N.Y., 58 pp., 75¢, 1959.—This is the seventh annual review of mining developments in Asia and the Far East based largely on information obtained from governments and government agencies. • • •

STATE PUBLICATIONS

Alabama

Geological Survey of Alabama
P.O. Drawer O
University, Ala.

Surface Water Resources and Hydrology of West-Central Alabama, Special Report 24, 12¢ postage, 1959.

Arizona

Arizona Bureau of Mines
The University of Arizona
Tucson, Ariz.

Geologic Map of Gila County, 75¢, 1960.

Colorado

Colorado School of Mines
Golden, Colo.

Theoretical and Practical Treatment of Expansive Soils, $2, 1959.
Petrology of the Fountain and Lyons Formations, Front Range, Colorado, $3, 1960.

Illinois

State Geological Survey
Natural Resources Bldg.
Urbana, Ill.

Solvent Extract and the Plastic Properties of Coal, Circular 288, gratis, 1960.
Effect of High-Carbon Components and Other Additives on the Character of Cokes, Circular 289, gratis, 1960.
Lightweight Aggregate from Illinois Shales, Circular 290, 1960.
Ground-Water Geology of Winnebago County, Illinois, Report of Investigations 213, 25¢, 1960.
Upper Mississippian and Pennsylvanian Megaspores and Other Plant Microfossils from Illinois, Bulletin 86, 1960.

Division of Industrial Planning and Development
116 State Capitol Bldg.
Springfield, Ill.

Atlas of Illinois Resources Section 2 Mineral Resources, $2, 1960.

Kansas

State Geological Survey
University of Kansas
Lawrence, Kan.

The Mineral Industry in Kansas in 1958, Bulletin 134, Part 7, 50¢, 1959.
Marine Bank Development in Plattsburg Limestone (Pennsylvania), Neodesha-Fredonia Area, Kansas, Bulletin 134, Part 8, 50¢, 1959.
Dakota Formation Refractory Clays and Silts in Kansas, Bulletin 142, Part 1, 50¢, 1960.

Missouri

University of Missouri
School of Mines and Metallurgy
Rolla, Mo.

Fourth Annual Symposium on Mining Research, November 13-15, 1958, Technical Bulletin No. 97, $3.50, 1959.

Directory of Known Mining Enterprises, 1959, gratis, 1960.

North Dakota

Wilson M. Laird, State Geologist
Grand Forks, N. D.

Geology of West Central McKenzie County, North Dakota, Report of Investigation 11, 80¢ 1960.

(Continued on page 878)

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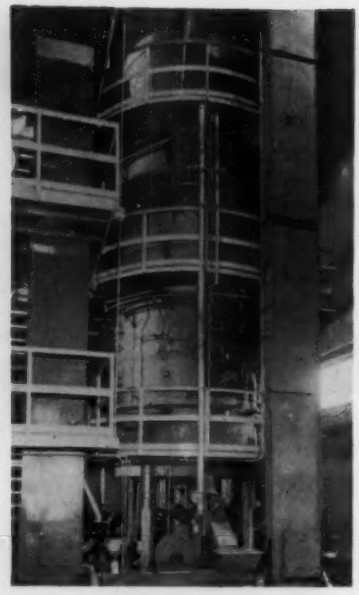

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Regional Gravity Map of Northwestern North Dakota, Report of Investigation 35, 50¢, 1960.
Contour Map of the Pre-Mesozoic Surface in North Dakota, Misc. Map No. 6, 50¢, 1960.
Pre-Mesozoic Paleogeologic Map of North Dakota, Misc. Map No. 7, $1.00, 1960.

Texas

Board of Water Engineers
1410 Lavaca St.
Austin, Texas

Geology and Ground-Water Resources of Winkler County, Texas, Bulletin 5916, gratis, 1959.

ABSTRACTS

In This Issue: *The following abstracts of papers in this issue are reproduced for the convenience of members who wish to maintain a reference card file and for the use of librarians and abstracting services. At the end of each abstract is given the proper permanent reference to the paper for bibliography purposes.*

Mineral Wealth and Industrial Power—Communist China's Boasts Begin to Come True by *K. P. Wang*—Within a decade, Communist China has been transformed from an agricultural economy to a nation with potentially powerful industrial capacity. The author believes that by 1962 Communist China will have surpassed the industrial capacity of Japan. "The accuracy of Communist China's industrial statistics can be questioned, but their order of magnitude is clear." The Communist regime's mineral industry already contributes 4.5 pct of the gross national product. Geological, mining, and metallurgical techniques are steadily improving, and technicians and industrial workers are rapidly being trained. Communist China appears to be more than self-sufficient in most minerals, both now and for the future. Ref.: (MINING ENGINEERING, August 1960) p. 901.

New Facilities Accelerate Chile's Iron Ore Exports by *A. T. Yu*—Shiploading facilities at Chile's twin ports, Chañaral and Caldera, have notably contributed to the rapid expansion of Chile's iron ore industry. The antiquated truck-to-lighter-to-ship method has been superseded by mechanized conveyor loading. Upon completion of the extended facilities at Chañaral, scheduled output of Chile's largest iron ore producer is expected to reach 3 million long tons for 1960. Ref.: (MINING ENGINEERING, August 1960) p. 913.

U. S. Strategic Materials Stockpiles and National Strategy by *John D. Morgan*—With only about 6 pct of the world's population, the U. S. uses from one to two thirds of the world's annual supplies of most metals and minerals. The U. S. strategic materials stockpiling program is designed to enhance our national security position. The author urges that the contemplated sale of some $3 billion worth of strategic materials be carefully evaluated in terms of our national security and the impact upon domestic economy and the economy of friendly foreign nations. Ref.: (MINING ENGINEERING, August 1960) p. 916.

Development of a Thermoadhesive Method for Dry Separation of Minerals by *R. J. Brison and O. F. Tangel*—An efficient process has now been developed for removing impurities from crude rock salt. Radiant heating selectively heats the impure particles, which are then removed by adhesion to a heat-sensitive coating on a conveyor belt. Ref.: (MINING ENGINEERING, August 1960) p. 920.

Beneficiation of Rock Salt at the Detroit Mine by *W. C. Bleimeister and R. J. Brison*—The first commercial unit employing the new separation process described in the article by Brison and Tangel has been installed at International Salt Co.'s Detroit mine. Heating unit and separation conveyor designs are illustrated, major problems and costs are discussed, and operation data are detailed. Ref.: (MINING ENGINEERING, August 1960) p. 925.

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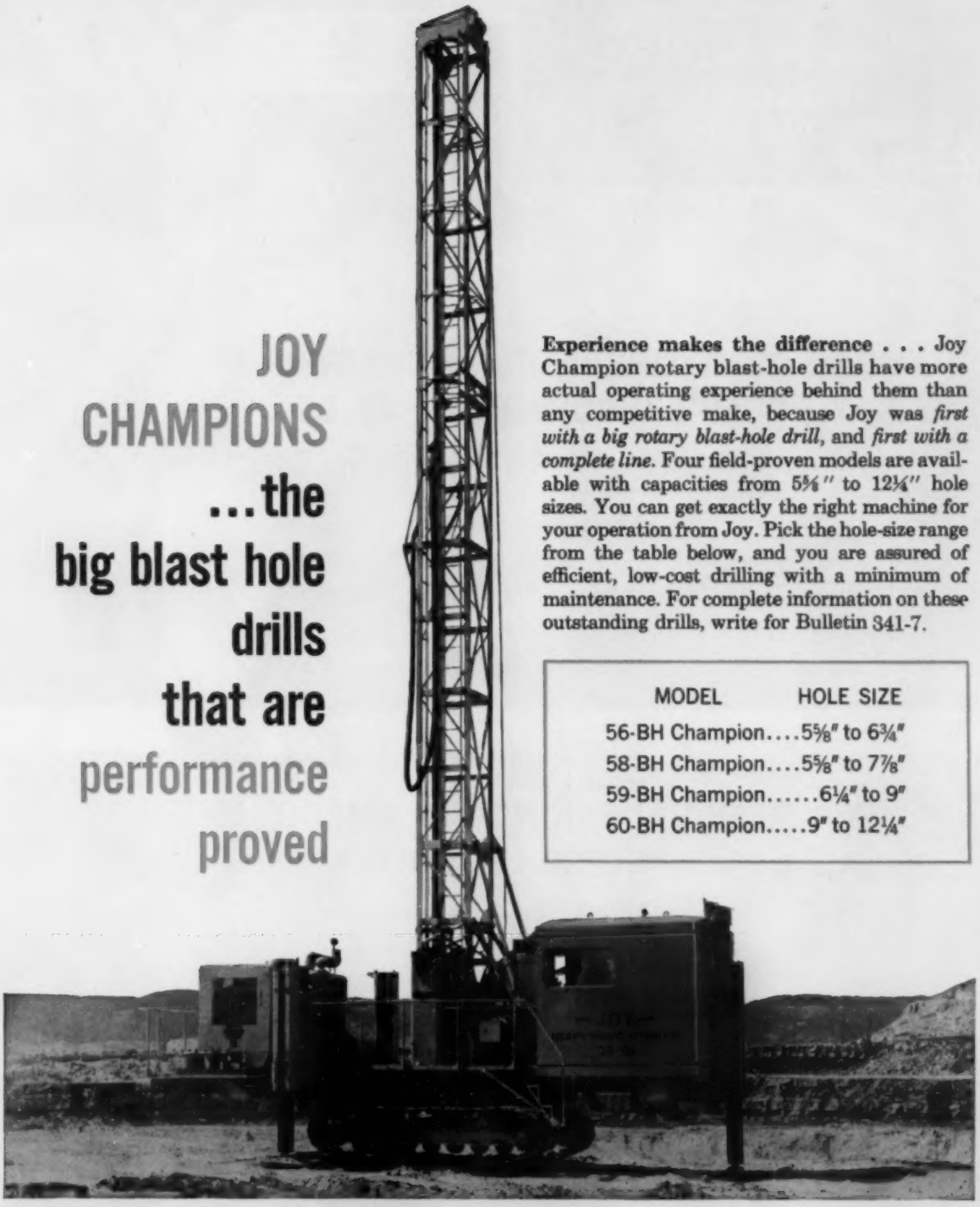

Experience makes the difference . . . Joy Champion rotary blast-hole drills have more actual operating experience behind them than any competitive make, because Joy was *first with a big rotary blast-hole drill*, and *first with a complete line.* Four field-proven models are available with capacities from 5⅝" to 12¼" hole sizes. You can get exactly the right machine for your operation from Joy. Pick the hole-size range from the table below, and you are assured of efficient, low-cost drilling with a minimum of maintenance. For complete information on these outstanding drills, write for Bulletin 341-7.

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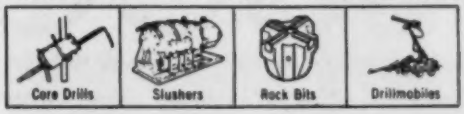

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AMSCO HELPS YOU HANDLE MORE TONS PER DOLLAR

AMSCO PUMP OPERATES 24 HOURS A DAY...PUMPS DISCHARGE 3 MILES

AT NEW ENGLAND DREDGE & DOCK COMPANY

On the dredge C. H. Cobb, operated by New England Dredge & Dock Co., the Amsco 12″ Form 50 S3B pump shown at right is "on duty" 24 hours a day, 6 days a week. It handles 5000 yards a day, pumps discharge over 3 miles with one booster... under 23 railroad tracks, through a mile-long railroad tunnel and through cliffs to a marshland.

Regarding this Amsco pump, installed 2½ years ago, Mr. C. H. Cobb, General Superintendent says—"Its performance and price make this the most desirable pump on the market".

JAW PLATES REDESIGNED IN AMSCO ALLOY...TONNAGE UPPED 75%

AT STAR ROCK PRODUCTS COMPANY

At Star Rock Products Co., Anaheim, California, crusher jaw plates previously used were giving only about 6 months' service. Large rocks dropped into the crusher often caused the jaw plates to "give" enough so the rocks wouldn't crush. Jams and costly delays resulted. Plates would often flow and crack.

Amsco collaborated on a redesign, using 2% chrome (Amsco MY) alloy. After 6 months' service, the plates were in excellent condition. Jams and delays have been eliminated, and tonnage handled *increased 75%*.

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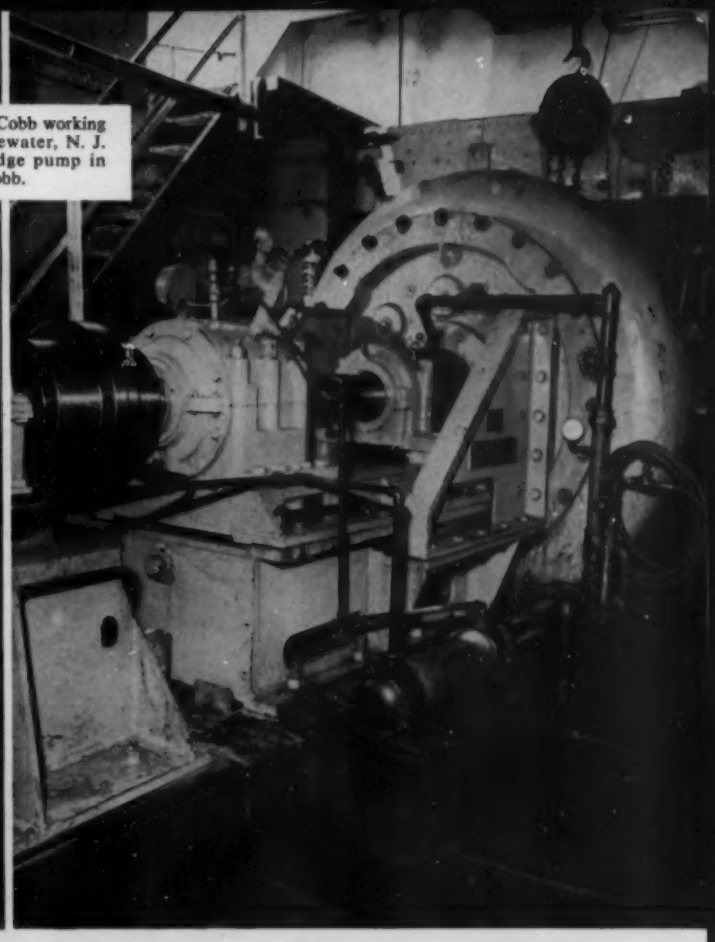
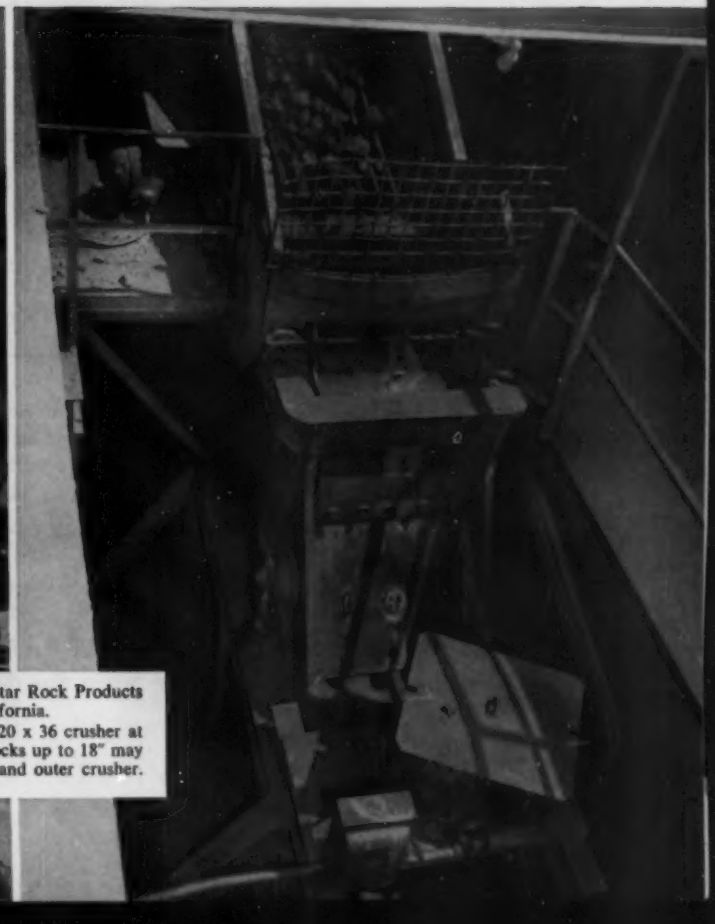
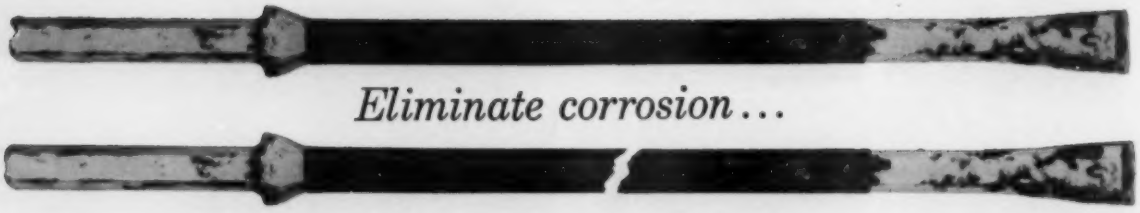


Left: View of dredge C. H. Cobb working around dock area in Edgewater, N. J.
Right: Amsco 50 S3B dredge pump in pump room on the C. H. Cobb.



Left: General view of Star Rock Products plant at Anaheim, California.
Right: View of Straub 20 x 36 crusher at Star Rock Products. Rocks up to 18" may pass through grizzly and outer crusher.



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for lower drilling cost...

with SANDVIK **Coromant** *SR-Treated Integral Steels!*

- Corrosion promotes breakage: You know, of course, the variety of mechanical stresses to which steels are subjected in work. Stresses cause fatigue; can cause premature rod breakage, before the normal tensile strength or even the yield point has been exceeded.

  In most cases, fatigue failure starts from the point where corrosion has set in. In other words, corrosion sets up the conditions for a fatigue break to occur. Except—when you use Sandvik Coromant Integral Steels! The exclusive Sandvik SR-treatment* protects against corrosion and provides from 30 to 50% longer life than untreated steels.

  You get other advantages too: Less loss of energy, since the bit is integral with the steel. There is no bit to "get lost". What's more, since Sandvik is one of the world's largest manufacturers of tungsten carbide, you get bigger and better inserts.

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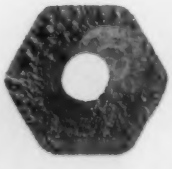

Appearance of a fatigue breakage that often arises with rods that have not been protected against corrosion. Sandvik's SR-treatment* protects against such failures.

*pat. pend.

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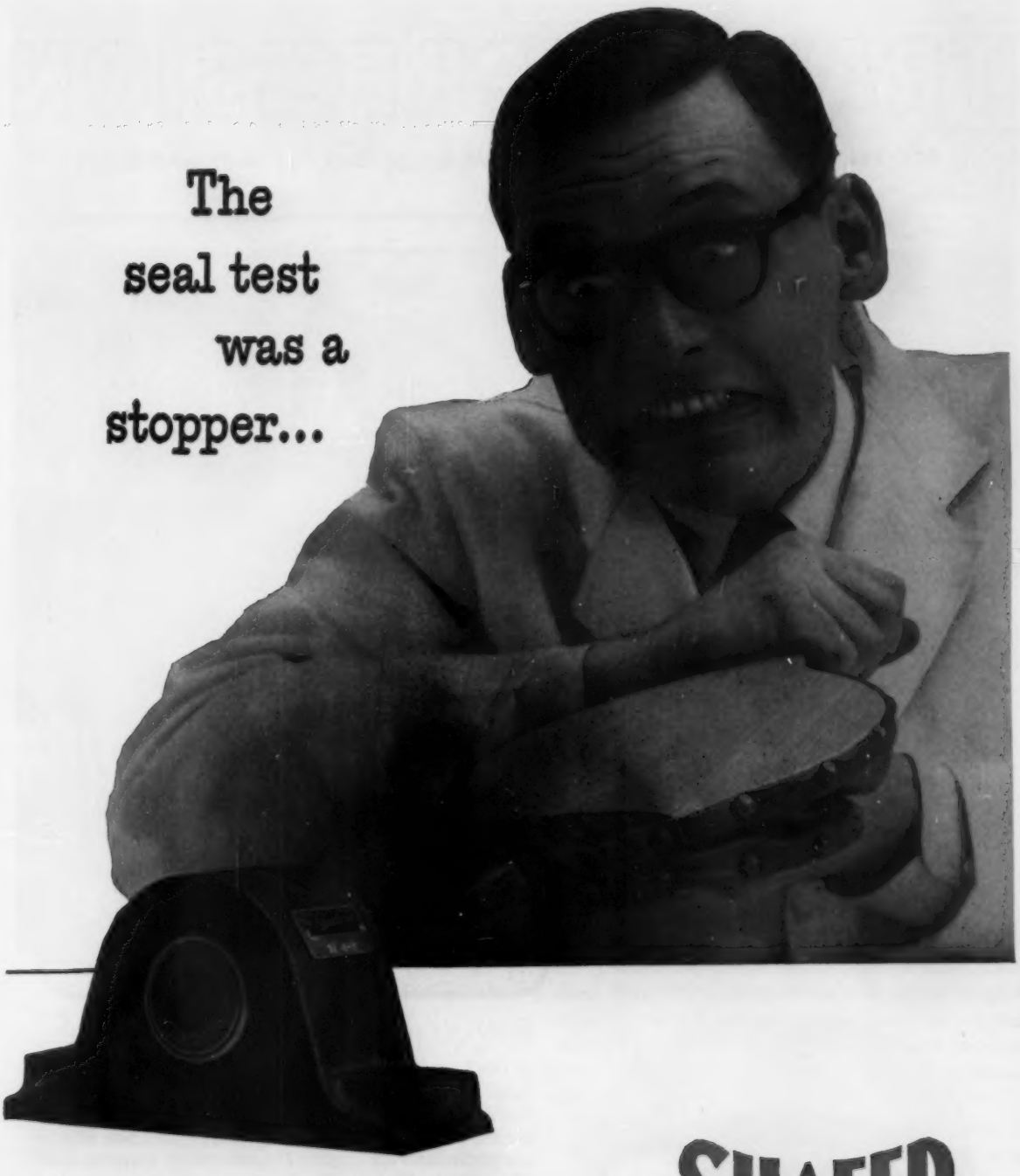

...in a lot of ways. Our tester wanted to stop the whole thing.

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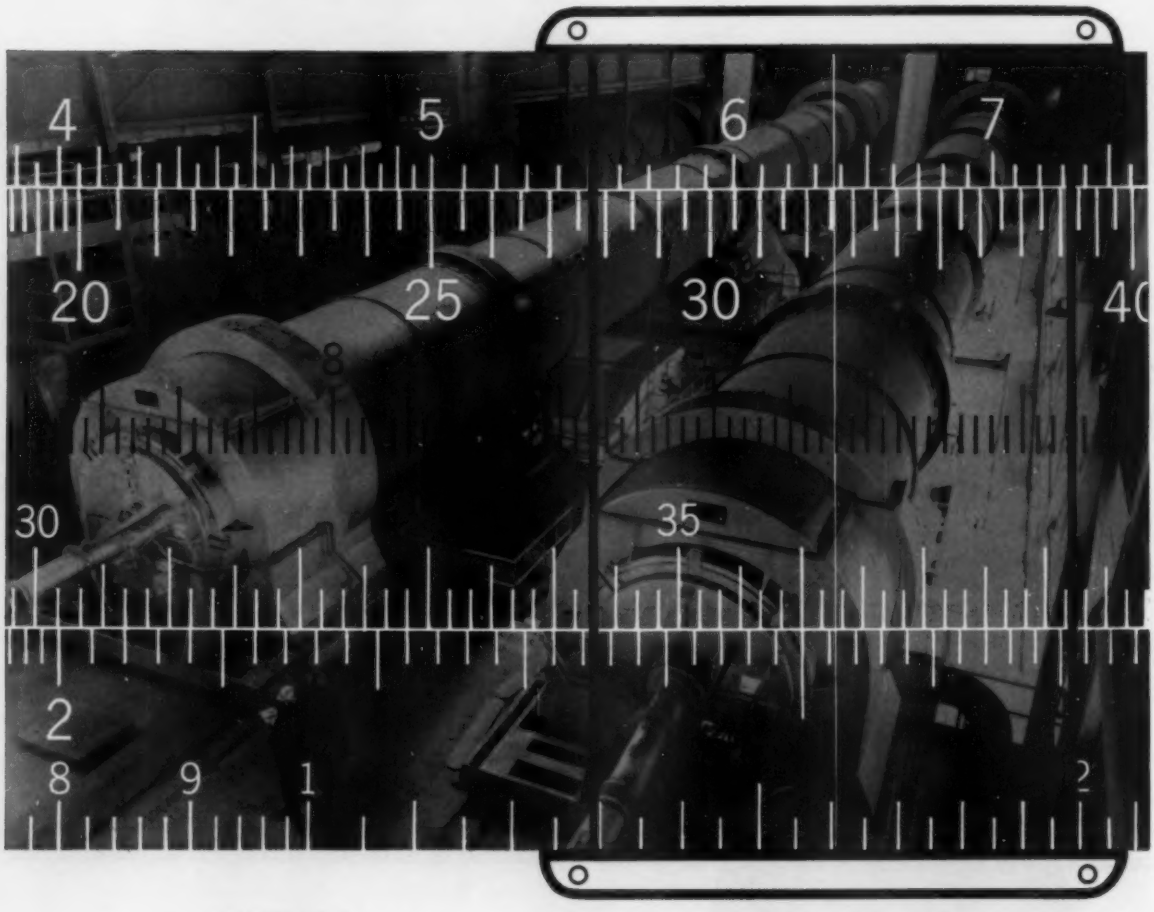

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Amyl Xanthate	0.12
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Cyanidation - 294 mtd.

AERO® Brand Cyanide	12.0
CaO	7.0
Zn dust	0.2

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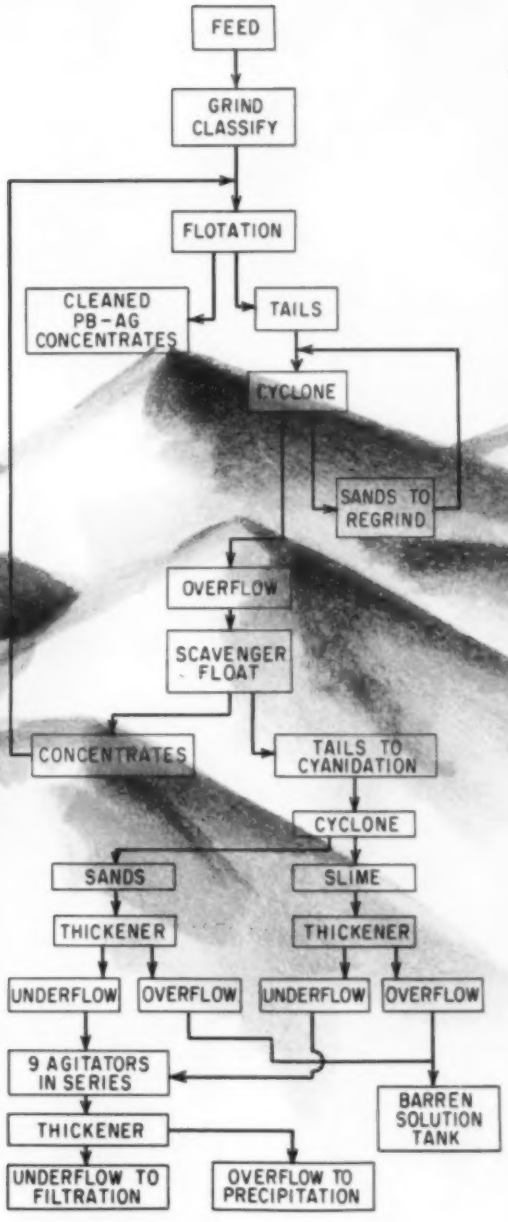
Start 0.202% NaCN equivalent 0.058% CaO
Finish 0.179% NaCN equivalent 0.042% CaO

TYPICAL RESULTS

Product	Au gm/ton	Ag oz/ton	Pb %	Recovery % Au	Ag	Pb
Flot. Feed	4.72	21.06	0.66	100	100	100
Flot. Conc.	183.7	801.4	26.8	77.6	75.9	77.4
Flot. Tails	1.08	5.17	0.16	22.4	24.1	22.6
Cyan. Tails	0.01	2.02		0.7	9.4	



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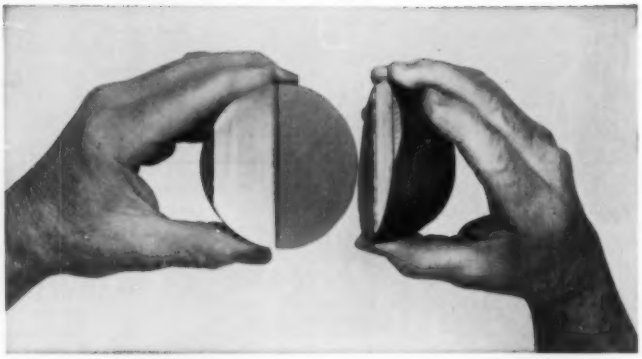

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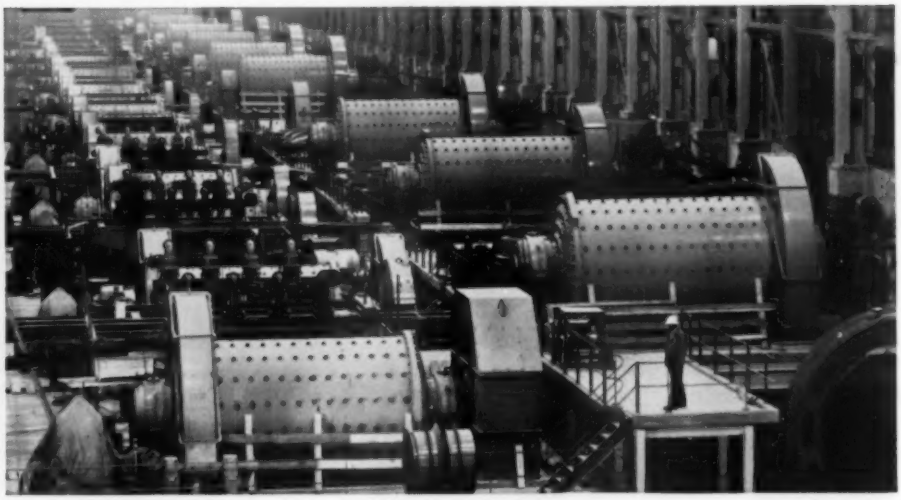

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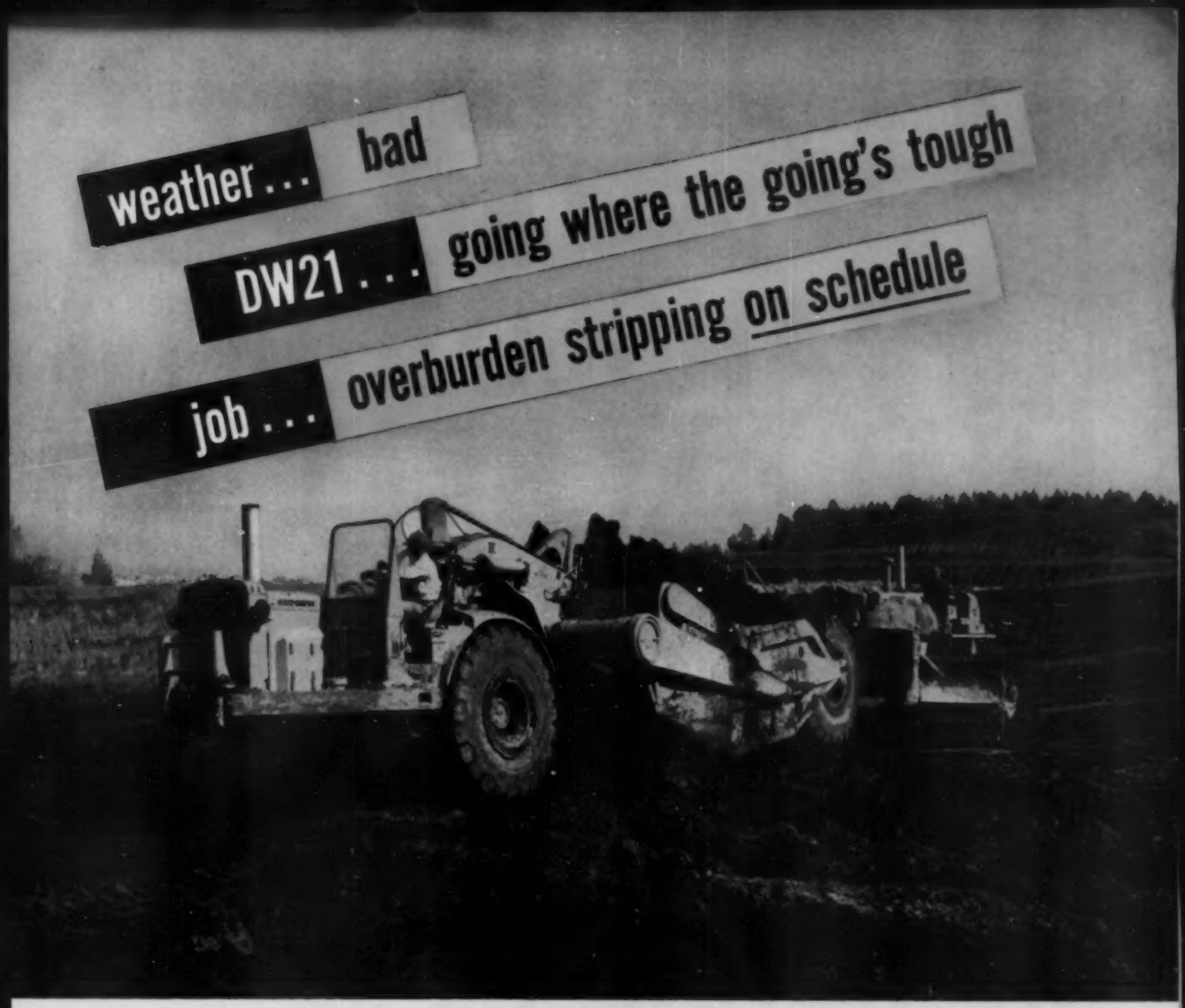

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WE WILL BE AT LAS VEGAS . . . with the S-D Transloader! At our Sanford-Day BOOTH 43, in addition to the Transloader, you will be able to view documentary movies showing exactly what the Transloader is doing *in action* underground to increase production at tremendous reduction in cost! We invite you to visit with us at BOOTH "43" . . . American Mining Congress, MINING SHOW, Las Vegas, Nevada, Monday-through-Thursday, October 10-13, 1960.

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Well here's photographic proof; from the Montana mines of The Anaconda Company, where the long life and outstanding performance of Ni-Hard* nickel-chromium-iron alloy liners have saved many thousands of hours of downtime. And done wonders for tonnage too — in both ball mills and rod mills, at the feed end as well as the discharge end.

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MINING engineering REPORTER

Congo Rioting Forced Closure of Katanga Mines

Rebellions in the Congo following Belgium's grant of independence at the end of June forced the shutdown of the Katanga province copper mines of the Union Miniere du Haut Katanga—major producer in the area, which accounts for 8 pct of the world's copper. A number of mine officials were reported murdered by mutinous Congolese soldiers and many European personnel were forced to flee to neighboring areas with their families. Conditions later became settled enough for some men to return to work and a number of mining operations have been resumed.

Huge Chile Minerals Survey Slated for 1961

A minerals exploration program centered about the Atacama desert of northern Chile and costing about $1.7 million will be started early next year under the sponsorship of the United Nations and the government of Chile. The hope is that the program of airborne surveys and diamond drilling will uncover deposits of minerals in addition to the copper and nitrates upon which much of the country's business is based, and thereby diversify the economy. A successful program would also help bolster the depressed area of northern Chile. Detailed plans for the proposed 2½-year quest are now in preparation.

Bureau of Mines is 50 Years Old

The Federal Bureau of Mines celebrated its golden anniversary on July 1. Created in a time of heavy human toll in the nation's coal mines, the Bureau has helped to advance the cause of safety and has branched out into areas which, in the words of Marling J. Ankeny, director, "touch, directly or indirectly, the lives of all Americans." Bureau scientists provided the U. S. with new metals like titanium and hafnium, he pointed out. The Bureau is also engaged in reporting research, industry statistics, and economic analyses on minerals, and in improving mining and beneficiation practices, to mention a few of many activities.

Christmas Mine Completion Set for 1961

The new Christmas, Ariz. mine of Inspiration Consolidated Copper Co.—a planned producer of some 18,000 tons of refined copper annually—should be completed late in 1961, the company said. Reserves are estimated to contain 20,061,625 tons of proven and probable ore averaging 1.83 pct to 1 pct Cu with a recoverable copper content of 330,000 tons of refined copper. Inspiration is optimistic over the likelihood of developing additional tonnages.

Lehigh's New Mining Engineers Command Average $497

A job analysis for the 1960 senior class at Lehigh University shows that the school's graduating mining engineers will start work with average monthly salaries of $497, two dollars or ½ pct more than last year. Company talent scouts held 42 interviews with the 19 mining candidates. Leading the salary lists were electrical engineers with an average of $540, up 7 pct, followed by mechanical engineers with $528, a 6 pct increase over 1959.

(Continued on page 894)

MINING engineering REPORTER

J&L Opens New Mine

The Lind-Greenway mine of Jones & Laughlin Steel Corp.'s Minnesota Ore Div. has started production and is expected to produce some 700,000 gross tons of beneficiated ore yearly. Two open pits are being worked.

Utah Beryllium Ore Find

Vitro Corp. of America describes as a significant deposit a beryllium ore discovery in the Topaz Mountain area of Utah, where its subsidiary, Vitro Minerals Corp., has large claims. Vitro Minerals said the ore is found in disseminated non-pegmatitic deposits, much of it lying near the surface. The company indicated the ore is apparently amenable to conventional hydrometallurgical processing. Laboratory tests are being conducted at Vitro Chemical Co.'s uranium plant at Salt Lake City.

Settle Iron Ore Claim Dispute

U. S. Steel Corp. and Union Steel Co., a Kaiser Steel Corp. subsidiary, have agreed to joint ownership of disputed iron ore claims located near Eagle Mountain in southern California. Neither company has plans for immediate development of the claim area. Kaiser is presently operating an iron ore mine at Eagle Mountain.

Explosives Plant on Mesabi

Hercules Powder Co. expects to finish a Gilbert, Minn. plant for the manufacture of blasting agents for taconite and other hard formations before September 1. The explosives are to be specifically designed for iron mining requirements on the Mesabi Range.

Big Copper Research Program

Primary producers and custom smelters of copper are plunging $300,000 into research this year to increase outlets for their products and to develop new products. The program, which is already under way with two technical research projects and two market surveys, is being conducted under the aegis of the Copper Products Development Assn.—a group with 18 corporate members.

Phosphate Facilities Sold

J. R. Simplot Co., of Pocatello, Idaho, has acquired the entire fertilizer plant facilities of the Anaconda Co. at Anaconda, Mont., and has leased Anaconda's phosphate properties at Conda, Idaho, on a long-term basis. Anaconda will operate the phosphoric acid and ammonium phosphate facilities for Simplot, which will market the products.

Uranium Ore-Buying Station Up for Sale

On July 27 the AEC placed on sale the equipment of the Moab, Utah uranium ore station. The unit was placed in standby condition on November 1, 1956, after the Uranium Reduction Co. mill went into operation and provided a market for ores in the area.

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MINING engineering **DRIFT**

THE YEAR OF THE PIG

For years Mao Tse-tung & Co. have been telling the world, in one way or another, that the Chinese people will make an all-out effort to achieve "Big Power" status among nations. These boasts are beginning to show signs of reality. This month, K. P. Wang, Far East Specialist of the U.S. Bureau of Mines, provides the readers of MINING ENGINEERING with an analysis of the mineral resources of Red China, which are assuming major proportions through a concerted program of exploration and development, and the effect of these resources on the growth of China's industrial power. The author has derived his information primarily from *unconfirmed* Chinese reports, and the views presented in his article entitled "Mineral Wealth and Industrial Power . . . Communist China's Boasts Begin to Come True" are not necessarily the same as the official views of the USBM. *The fact to be remembered is that many critical minerals in sufficient quantities are available to Chinese industry.*

For the Free World, the mounting success of China in its so-called "growth program" poses a very serious threat to world peace in the not-too-distant future. We do not deny the ambitions of other nations to seek and attain living standards comparable to ours—under more desirable circumstances, we would welcome China's emergence as a modern state. But our concern today is with a government that apparently cares less about contributing to the well-being of its people than about developing its muscle to dominate other nations.

No one can say with any degree of accuracy what price the Chinese people have paid, are paying, and will pay in the way of lives, living standards, and self-respect for industrial progress. To date, this has been of little concern to the rulers of the Chinese mainland. Reports filtering out of Communist China often carry the same message—crop failures, exterminations, "volunteer" labor, brain-washing, communal life, forced compliance—coupled with "official" claims of specific successes of the communistic way of life.

Ironically, the present Chinese year is known as *The Year of the Pig.* As pigs grow larger and become fatter, they also become hungrier. If China should someday achieve its goal as a major world power—and through such power, be able to subjugate and communize other areas of the world—its mineral resources will have played a silent, but leading role.

Read this article. Perhaps indirectly, it will stimulate the development of a sound mineral policy of our own which will allow us to meet successfully the continuing threat of an economic war with Communism. *Paul C. Merritt*

NOTICE—SME PREPRINT AVAILABILITY, 1960 ANNUAL MEETING

The following list of papers (from the 1960 New York Annual Meeting) will be available until Jan. 1, 1961. Coupons received with the 1960 dues bills and those distributed at the 1960 Annual Meeting will also expire on this date. Purchased coupons books will be honored on any future date. A new listing of available papers will appear in a forthcoming issue. It will include additional papers presented at the 1960 Annual Meeting (New York) and at other SME meetings throughout the year. **Preprints may be obtained (upon presentation of properly filled out coupon) from SME Headquarters, 29 W. 39th St., New York 18, N. Y.** Coupon books may be obtained from SME for $5 a book (10 coupons) for members or $10 a book for nonmembers. Each coupon entitles the purchaser to one preprint.

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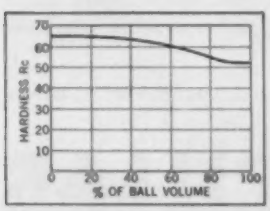

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MINERAL WEALTH AND INDUSTRIAL POWER

COMMUNIST CHINA'S BOASTS BEGIN TO COME TRUE

By K. P. WANG
Far East Specialist, US Bureau of Mines

Under the Communist regime marked industrial progress has been achieved on the China mainland. Within a decade, the country has been transformed from an economy primarily agricultural to one bristling with industrial possibilities. The industrial capacity of Communist China is beginning to approach that of Japan and will probably surpass it by 1962, the last year of the Second Five-Year Plan. The slogan already is *Beat the United Kingdom by 1972*, a goal which most observers feel will be achieved ahead of schedule. During the early years of the industrialization program in Communist China, emphasis has been placed on basic goods; hence additional time will be needed to make large quantities of the more complicated products. However, regardless of the current stage of industrial development, it is apparent that the necessary forward momentum has been created. The many capital construction projects being brought into production and the additional projects being initiated confirm this observation. The accuracy of Communist China's industrial statistics can be questioned, but their order of magnitude is clear. To properly evaluate the industrial capability of the country, differentiation must be made between the absolute quantities that reflect overall strength and the per capita quantities that reflect living standards. While Communist China is well on the road to becoming a world power, its living standards will remain below European levels for many years to come.

The mineral industry looms large in the industrial framework as well as the overall economy of Communist China. In fact, it already contributes significantly to the gross national product, the 1958 value of mineral output having been about 4.5 pct of the *GNP*. The Communist regime fully realizes that the key to China's industrial progress lies in the uncovering and efficient utilization of its mineral wealth. To implement the program, at least four ministries connected with minerals and metals have been established—Coal, Petroleum, Geology, and Metallurgical Industry. Mineral technologists have been sent to the far corners of the country, and reports on new finds and extension of known ore bodies have been numerous. Geological, mining, and metallurgical techniques are constantly being improved. It is a fallacy to assume that the Chinese Communists are not cost conscious and do not believe in efficient practices.

Editor's Note: Map of China containing locations of principal mineral facilities appears on page 906.

Great strides have also been made in training technicians and industrial workers to supply the manpower needed in mineral development. Some of the credit for China's success must be attributed to the Soviet Union which has furnished a great deal of technical assistance, supplied or helped design many mine plants, purchased most of Communist China's exportable mineral products, and provided China with large quantities of petroleum it temporarily needs.

K. P. WANG, Member AIME, is Far East Specialist, Division of Foreign Activities, U.S. Bureau of Mines, Washington, D. C. Paper was presented at the 1960 AIME Annual Meeting and published in *Mineral Trade Notes*, Special Supplement No. 59, U.S. Dept. of the Interior, March 1960.

Table I. The Present and Future Status of Communist China's Less Known Minerals Products[1]

	Estimated 1958 Production (Metric Tons)	Estimated 1962 Production (Metric Tons)	Present Status	Future Significance
Metallic				
Aluminum	27,000	100,000	Deficient	Moderate
Cadmium	Small	Moderate	Adequate	Moderate
Chromite	Small, if any	Unknown	Deficient	Unknown
Cobalt	Small, if any	Unknown	Deficient	Unknown
Copper, mine	30,000	120,000	Deficient	Moderate
Copper, refined	70,000	150,000	Greatly deficient	Moderate
Copper, scrap	100,000	Unknown	Supplies limited	Small
Gold	Moderate	Moderate	Adequate	Moderate
Lead, mine	47,000	110,000	Small surplus	Moderate
Lead, refined	60,000	120,000	Slightly deficient	Moderate
Lead, scrap	30,000	Unknown	Supplies limited	Small
Magnesium	1,000	3,000	Adequate	Moderate
Nickel	Small, if any	Unknown	Deficient	Small
Silver	Moderate	Moderate	Adequate	Moderate
Zinc, mine	45,000	120,000	Small surplus	Moderate
Zinc, refined	41,000	100,000	Slightly deficient	Moderate
Minor metals	Small	Moderate	Adequate	Moderate
Nonmetallic				
Alumina	60,000	250,000	Adequate	Moderate
Bauxite (diasporic)	150,000	500,000	Surplus	Great
Barite	50,000	100,000	Adequate	Moderate
Clays	Unknown	Unknown	Adequate	Moderate
Diamonds (industrial)	Small	Moderate	Deficient	Moderate
Gypsum	400,000	800,000	Adequate	Fairly great
Limestone	15,000,000	25,000,000	Adequate	Great
Phosphate rock and apatite	300,000	1,000,000	Deficient	Moderate
Phosphates (chemical)	344,000	1,500,000	Deficient	Moderate
Potassium fertilizer	Small	200,000	Deficient	Moderate
Quartz (piezo-electric)	600	1,000	Large surplus	Moderate
Silica (glass quality)	Unknown	Unknown	Adequate	Moderate
Fuels				
Crude petroleum	2,260,000	6-7,000,000	Greatly deficient	Moderate
(Natural crude)	1,100,000	5-6,000,000	Greatly deficient	Moderate
(Oil from shale)	1,100,000	1-2,000,000	Could use more	Moderate
(Synthetic oil)	Small	Small	Could use more	Moderate
Refined petroleum	2,900,000	6-7,000,000	Greatly deficient	Moderate
Natural gas	Small	Small	Could use more	Moderate

[1] Estimated by author.

WORLD SIGNIFICANCE OF CHINESE MINERALS

Mainland China has been traditionally world famous in antimony, tungsten, and tin production. In 1958 it ranked first in antimony and tungsten and second in tin. Less noticed but already becoming prominent in the world picture (particularly with regard to markets in Sino-Soviet Bloc countries) are the metallic mineral products such as bismuth, mercury, manganese ore, and molybdenite, recent output of which constitute between 4 and 10 pct of the world total. Several nonmetallics are also of considerable importance, with their production ranging from 8 to 20 pct of the world total; these include salt, fluorite, graphite, magnesite, and talc. In the construction, chemical, and insulating material fields, five items—cement, asbestos, mica, pyrite, and sulfur—comprise 2 to 4 pct of world total.

Probably the most outstanding developments in the mineral field are in the production of coal and of iron and steel. Chinese coal output is steadily rising and now ranks third in the world, constituting more than 10 pct of world production. If energy can be considered a good gauge of gross national product for a country, it is pertinent to mention that the 1959 output of coal, which is the main source of energy in mainland China, was about five times that

Table II. Rise in Chinese Mineral Production During 1949-59, Selected Commodities[1]

	Pre-1949 Peak[2]	1949	1952	1957	1958	1959
Coal	61,900	31,000	66,600	128,000	270,000	335,000[3]
Iron ore	11,000	500	4,290	15,000	30,000	45,000
Pig iron[4]	2,000	246	1,928	5,940	9,500	13,000
Crude steel[4]	1,000	158	1,350	5,350	8,000	12,000[3]
Rolled steel	700	140	1,100	4,260	6,000	8,000
Crude petroleum	320	120	440	1,440	2,260	3,500
Cement	2,300	660	2,860	6,860	9,300	12,500
Salt	5,100	2,000	4,950	8,280	10,400	13,000
Chemical phosphate	0	0	small	120	344	700
Manganese ore	80	1	191	700	850	1,000
Tungsten concentrate	15	5	20	15	15	15
Antimony	40	4	8	15	15	15
Tin	15	4	10	24	25	26
Copper, refined	3	2	10	50	70	80
Lead, refined	12	2	7	45	60	75
Zinc, refined	7	0	9	37	41	60
Aluminum	9	0	0	20	27	60

[1] Partly estimated by author.
[2] In most instances, the pre-1949 peak year was 1943. Major exceptions include antimony during 1916 and tin, tungsten, and manganese during the late 1930's.
[3] Represent target data. Preliminary claims for coal and crude steel output were respectively 347,800,000 and 13,350,000 metric tons.
[4] Excludes 4.2 million tons of off-grade pig iron and 3.1 million tons of off-grade steel for 1958 and an estimated 5.5 million tons of off-grade pig iron and several million tons of off-grade steel for 1959.

of the pre-1949 peak year. Chinese iron and steel output also has attained noteworthy levels. Now the seventh largest world producer, Communist China may reach fifth position by 1965. Many other mineral industries are undergoing rapid expansion, and most will become medium-size by world standards within five years. Three charts (Figs. 1, 2, and 3) are presented to indicate the relative world importance of Communist China's major mineral products during 1958. The changing status of the less known Chinese mineral products are shown in Table I.

GROWTH OF THE MINERAL INDUSTRY

China has long been considered as having mineral resources adequate to support a moderate scale industrial program. Having an area slightly larger than that of the U. S., its mineral wealth can be considerable. However, the extent of resources was largely unknown until extensive geological work, coupled with vast new knowledge gained through active mineral exploitation in recent years, demonstrated that the country has a sufficiently diversified mineral base to become a first rank industrial power. With the assurance of new ore supplies, rates of extraction have been stepped up rapidly. Chinese mineral output has topped pre-Communist peak levels in almost every case. The value of overall Chinese mineral output measured in terms of constant prices (1958) reached approximately $3 billion (U.S.) in 1958, or more than four times the annual maximum amount produced during the period before the year 1949 when Communist rule began. Fig. 4 shows the marked growth that took place from the pre-1949 period to 1958.

The work in the mineral field from 1949-52 dealt primarily with rehabilitation and reconstruction, and output of most mineral products was brought up to the past peak levels. The First Five-Year Plan (1953-57) was then launched with emphasis upon building new mine plants and planning for others in the future. Mineral output doubled between 1952 and 1957. Then, in 1958, came the "Great Leap Forward", signalling the beginning of the Second Five-Year Plan. At this time, some projects started during the First Five-Year Plan period began to bear fruit.

However, the most important developments in 1958 relate to the overall economy of Communist China rather than just the mineral industries; it was in the fall of this year that the communes and the "mass line" were introduced. As many as 60 million people were taken off the farms to look for minerals, work in coal mines, and smelt iron. Although this program dislocated the country's economy as a whole and agriculture in particular, it served a useful purpose to the mineral industry with regard to accumulation of information on resources and in training a large number of persons in the fundamentals of mineral extraction. The by-product of this program was another great increase in mineral production, coal and steel output being respectively more than 100 pct and 50 pct greater in 1958 than in 1957. The "backyard" program has since been junked, but it set the stage for growth of many small and medium semi-modern industries which are gradually taking its place. Consolidation of mineral enterprises took place in 1959, coupled with a further moderate increase in mineral output. Table II shows the growth of the mineral industry in terms of selected products for various years.

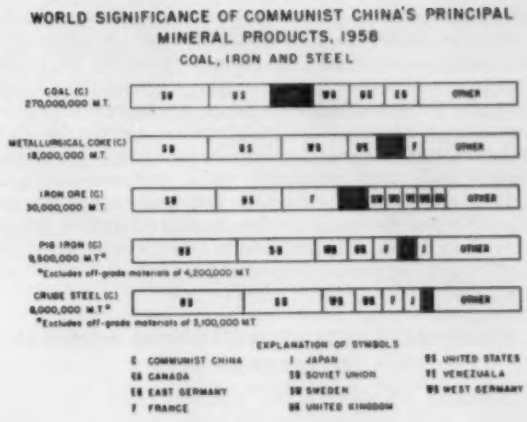


Fig. 1

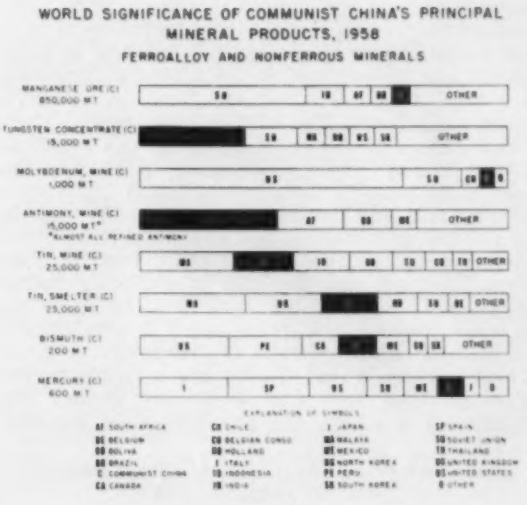


Fig. 2

MINERAL SELF-SUFFICIENCY

Communist China appears to be more than self-sufficient in most minerals, both for the present and for the future. However, some items are in short supply. The coal and iron ore base is very strong; coal, including coking coal, has long been considered rich, whereas iron ore has proved to be much more extensive than formerly thought. Petroleum is inadequate, but extensive exploration in recent years shows that the country will be prominent in this field five to ten years from now. Of the ferroalloy minerals needed to support steel production, manganese, tungsten, and molybdenum are abundant but chromium and nickel have not shown much promise. Copper, lead, and zinc reserves seem to be large enough for medium scale operations. However, a great shortage of copper exists, and Communist China's thinking is directed towards substitution of copper by aluminum to the extent feasible. The future possibilities for making aluminum and magnesium are fairly good although not enough has been produced so far. Antimony, tin, bismuth, and mercury are of first rank, both in resources and production. With regard to minerals for making

chemicals and fertilizers, the salt supply is excellent, sulfur is moderate, and phosphate ore is extensive but not yet extracted in enough quantity to meet China's requirements. Generally, Communist China has very diversified and large resources of nonmetallic minerals. Fluorite, graphite, magnesite, and talc are well known. In recent years much asbestos, barite, industrial diamonds, mica, and piesoelectric quartz have been discovered. The long-term reserve position for minerals in Communist China is illustrated in Table III, and the present status of self-sufficiency for certain mineral products is evaluated in Table I.

REGIONAL FACTORS AFFECTING MINERAL DEVELOPMENT

Because of Communist China's large territory, varied geological and geographical conditions, limited transportation, and uneven population distribution, there are many regional factors affecting mineral development. Manchuria has often been referred to as the "Ruhr" of China, but its significance extends beyond the industrial aspects since agriculture and forestry are also important there. Most of the major industrial and mineral facilities in Manchuria are concentrated in the Liaotung Peninsula, a district that has about one-third the country's industrial capacity. The relative importance of Manchuria, however, has been declining as a result of efforts by the Chinese Communists to build up the rest of the country. Neighboring North China with its vast coal and iron resources is steadily gaining in stature; an industrial belt stretching from Chinwang-tao west through T'ang-shan, Tientsin, Peiping, Ta-t'ung, and Pao-t'ou is gradually taking shape; and Sian, in an area of rich mineral resources, is being groomed as a spring-board to development of both the Northwest and the Southwest. Central China has the Wuhan heavy industry base on the Yangtze River that may eventually become the "Chicago" of China, the Shanghai light industry

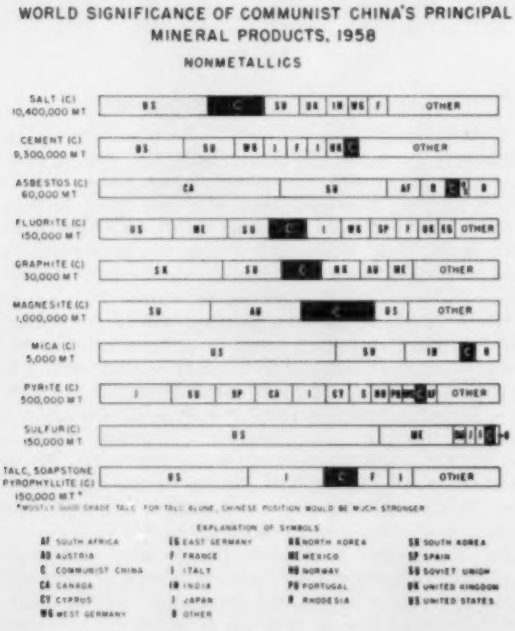


Fig. 3

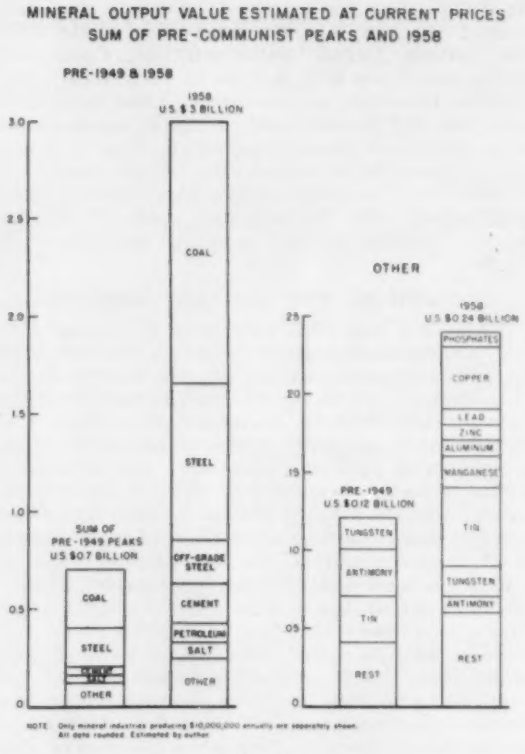


Fig. 4

base that also has become important in iron and steel, fairly good transportation, and diversified mineral resources. Southeast China is the heart of the tungsten and antimony industries with a new industrial area being developed in Kwangtung Province. Southwest China has tin, copper, mercury, and some oil. The vast northwest is yielding increasing quantities of petroleum, radioactive minerals, and nonmetallics. Most regions have adequate resources of both coal and water power.

The population concentration of Communist China is such that more than 80 pct of the people live in the eastern one-third of the country. In contrast, much of the undeveloped mineral wealth lies in the remaining sectors of China. The Communists have been trying to open up the west with a coordinated program of transport and industrial development. Some railways have been designated to tap known mineral resources, whereas others are part of the program to uncover new workable deposits. There also has been better distribution of industrial products. However, inadequate transport facilities are definitely holding back mineral development. To compensate for this, considerable emphasis has been placed upon building local industries around resources and markets—a program which has met with partial success.

MANAGEMENT OF THE MINERAL INDUSTRY

It is too early to tell whether the Communist Chinese system of managing mineral enterprises will be very effective in the long run. However, results so far achieved in terms of training, development, and production have been notable. Management is through dual authority: the Communist

Party, locally represented by the Party secretary and the cadre, and the Ministry or Provincial agency, locally represented by the supervisor and the technician. A spirit of cooperation as well as spying on others is instilled in the worker, who is made to feel that a mine or plant belongs not only to the state but also to him and he must do his best for it. Good work is rewarded through recognition as model workers, record holders, opportunities to pursue further education, special privileges, additional compensation, and promotion. Opinions of workers are solicited, and meetings are frequently held to discuss operational problems. The cadre and supervisors maintain very close relationship with the miners and plant workers, and they often work and live like them. There are no strikes. The Party slogan for the masses is *Tuo-k'uai-hao-sheng*, meaning greater output, faster operations, better quality of products (and work), and more economical practices.

Steps have been taken to improve operational techniques. A technical resolution movement has been underway for some time. Workers and technicians are urged to "dare-to-think and dare-to-do," and there has been a daring and at times reckless spirit of trying to break technical barriers. At the same time, however, safe production is stressed; in fact, a whole series of mine safety regulations and education programs have been put into effect and they seem to have improved working conditions. Many national conferences are held to exchange experiences in technology, and there is no hesitation to adopt techniques successfully applied elsewhere. Large scale pilot plant tests for new methods are started soon after ideas are conceived; failures are minimized and successes are common. Special design and basic construction groups have been organized to develop new mines and plants. Many research organizations, either independent or associated with universities, have been established, and their work is closely coordinated with planning and design groups as well as by mines and plant staffs.

A production war with regard to both operations and technology is being waged continuously. Herein lies the great danger of letdown or breakdown on the part of the workers, who have been kept at a high and tense working pitch for so long. There is no question that the workers have been straining to the utmost for "the good of the state." Overwork and fatigue in trying to meet production goals might well have their toll. A fair amount of bureaucratic hoarding of equipment, supplies, and technical manpower to the detriment of overall mineral development can be expected. However, output levels have been brought up so much that even a letdown would still leave fairly high levels of production.

PRESENT LEVEL OF MINERAL TECHNOLOGY

The technological level of the Chinese mineral industry is uneven. On the one hand, there are a number of large and very modern mine and plant facilities and on the other hand, a multitude of medium and small scale operations, some semi-modern and others fairly primitive. The "backyard furnace" type of simple operations, which was created more on the basis of political rather than economic considerations and has since passed from the limelight, received the most attention from the press. However, it is the semi-modern and modern operations that are of far greater importance. The semi-modern operations, which may contribute about one-third of the Chinese mineral output, are particularly suited for a country like Communist China where equipment is inadequate and expensive and manpower abundant and relatively cheap. The so-called modern operations, which produce most of the mineral products in the country, are fairly up-to-date from the engineering point of view but, while comparing favorably with European and Japanese practices, are much lower in productivity than U.S. operations. The reason again is that in any Asiatic country "poor man's engineering" must be applied, which is good in quality but not in productivity. Generally speaking, the overall level of mineral technology in Communist China has advanced rapidly in the last decade; the technologic gap between the Orient and the West is narrowing. In fact, some practices in Communist China compare with the best in the world.

Table III. 1959 Mineral Reserve Position of Communist China (Selected Commodities)

	First Rank	Large Reserves	Moderate Reserves	Little Known
Coal, Oil, and Iron	Coal Coking Coal Iron Ore		Oil	
Ferroalloy Minerals	Tungsten Molybdenum	Manganese		Chromite Molybdenum Nickel
Nonferrous Minerals	Antimony Tin Bismuth Mercury	Aluminum Magnesium	Copper Lead Zinc Gold Silver	Copper Lead Zinc Gold Silver Platinum
Chemical Materials	Salt	Phosphates	Pyrite Sulfur Potassium Ores	Pyrite Sulfur
Nonmetallics	Fluorite Graphite Magnesite Talc and Soapstone	Alum Asbestos Mica Quartz (Piezo-electric) Gypsum	Barite Diamonds	Barite Diamonds Mica Quartz (Piezo-electric)

1. Hokang
2. Chihsi
3. Fushun
4. Fuhsin
5. Anshan
6. Hai-ch'eng
7. Kai-p'ing
8. Ying-k'ou
9. Hu-lu-tao
10. Yang-chia-chang-tzu
11. Kailan
12. Ch'ang-lu
13. Ta-t'ung
14. Pao-t'ou
15. Nan-ting
16. San-men Gorge
17. Chin-p'ing
18. Huainan
19. Hsiang-shan
20. T'ung-kuan-shan
21. Hsin-an Chiang
22. Nan-ch'ung
23. Tzu-liu-ching
24. Shih-mien
25. Chang-te
26. Wu-yi
27. Hsi-k'uang-shan
28. T'ung-jen
29. Hui-li
30. Tung-ch'uan
31. Shui-k'ou-shan
32. Hsi-hua-shan
33. Fu-ho-chung
34. Ying-te
35. Ku-chiu
36. Chan-chiang
37. Yunnen
38. Karamai
39. Tu-shan-tzu

Exploration and drilling are being done on an extensive scale, and many new mineral deposits have been discovered. In late 1959 about 400,000 "geological workers," including nearly 30,000 trained in institutes of higher learning or secondary schools, reportedly were in the field prospecting for minerals. Drilling machines (primarily diamond drills) in use for exploration purposes now total more than 6,000, and the footage drilled since 1949 has been reported at about 25,000,000 meters or more than 100 times as much as that done in the preceding half century. Many geophysical and geochemical instruments are used, and aerial surveying is being applied to a considerable extent. The technical level in mining and metallurgy and the manpower organized to do the work have been equally impressive. Most mines can excavate vertical shafts and horizontal tunnels at monthly rates of 50 and 100 meters respectively. Advanced methods of shaft sinking such as freezing, drop shaft, and sheet piling, are increasingly employed. In coal mining, combines (cutter-loaders) and cutters are used more and more, and hydraulic extraction is rapidly gaining in importance. Mill recoveries are approaching world standards. The Communist Chinese have a number of very large and efficient blast and open-hearth furnaces in operation. A vertical retort zinc plant apparently performing as well as any in the world is in existence. The Chinese have long been familiar with tin and antimony smelting. Minor metals and high purity metals are now being made. Moderately large scale mines and plants of all kinds can be designed and built as long as they are not too complicated; most of the simpler mining and metallurgical equipment is made domestically. As would be expected for a country just starting to industrialize, fabrication and processing are still behind world standards. However, with the extensive mineral resources and the basic ingenuity of the people at their command, the Chinese Communists should master the weaker phases of mineral technology in time. Accomplishments already made in mineral development indicate bright future prospects in overall industrial progress.

MAJOR SECTORS OF CHINA'S MINERAL INDUSTRIES

COAL

Coal is Communist China's most valuable mineral asset, both for the present and the future. It is also the chief source of energy and metallurgical fuel. The latest Communist Chinese claim on overall coal resources is 9.6 trillion metric tons (100 billion tons "verified") which might be greatly exaggerated according to western standards of coal reserve classification. The important point, however, is that the coal reserve of Communist China definitely ranks among the foremost in the world along with those of the United States and the Soviet Union. Recent exploration also has uncovered large coal beds in Central, South, Southwest, as well as Northwest China which hitherto had been considered inadequate in coal for large scale industrial development. About 30 large coal fields are said to be in existence around the country. Most of the coal is bituminous and seven of these fields have large tonnages of coking coal.

The coal industry is being rapidly expanded, output having doubled between 1957 and 1958 and risen another 25 percent between 1958 and 1959. The goal for 1959 production was 335 million metric tons of mine-run coal, which reportedly was more than fulfilled (347.8 million tons claimed). This constitutes 10 pct of world production. Thus, Communist China has achieved third rank in world coal output, even when discounting a maximum of 20 pct due to losses in coal beneficiation and possible statistical exaggerations. The fact that Communist China will soon have approximately a 100 million-ton-per-year capacity in coal cleaning facilities speaks well for technological progress in controlling coal quality. Developments in mine construction and coal extraction are equally impressive; productivity is approaching European standards and advanced techniques like cutter-loader and underground hydraulic operations are employed at all large mines.

Seven coal-mining centers (Fushun, Fuhsin, Kailan, Huainan, Hokang, Chihsi, and Tatung, in order of output) each produced more than 10 million metric tons of mine-run coal in 1959. Another 20 to 25 mining centers produced between 1 and 10 million metric tons during 1959. The rest of the output came from medium and small mines scattered around the country.

Despite the large output, there is no surplus of coal. In fact, because of distribution difficulties, shortages may exist on occasions in some areas. Most of the major coal centers are oriented towards industrial complexes, whereas medium and small mines are developed to meet local needs. Household heating is still the most important item of coal consumption. However, of the 270 million metric tons of mine-run coal reportedly produced in 1958, about 30 pct was used for iron and steel smelting, 12 pct for power purposes, 6 pct for railroad use, and 5 pct for coal mine use. Efficiency in utilization is being steadily improved. There has been a tendency to disperse coal production as much as possible to alleviate distribution bottlenecks due in part to inadequate transportation facilities.

PETROLEUM

The Chinese Communists have high hopes for the future development of the petroleum industry as a result of significant discoveries made in recent years through an extensive program of drilling and exploration. Approximately 300 rigs are said to have been used for oil exploration in late 1959. Reserve data have been steadily revised upwards, the latest figure claimed on measured oil reserves being about 200 million metric tons (a metric ton of crude is roughly equal to 7.7 barrels) and a total estimated reserve of as much as 5.9 billion tons. The true potential can only be ascertained in time, but the country should no longer be considered poor in oil. Since most Chinese oil is in the west where population density is low, the development of transport facilities including pipelines and the building of more industries in the hinterland would basically affect the growth of the oil industry. Not to be ignored in the Chinese oil picture are the extensive resources of oil shale and coal from which oil can be extracted or made. The natural gas resources also show promise.

Communist China's oil output, while increasing, is still small and inadequate to meet current needs. Prices are much above world levels because of the great demand. The 1959 production reached an all-time high of probably more than 3.5 million tons, but several million tons of Soviet petroleum still had to be imported. Refinery capacity in Communist China was a little larger than crude oil output at the end of 1959 and is being built according to the requirements of crude oil. Dependency on foreign petroleum is expected to decline, if not entirely cease, within the next five years in view of the stepped-up production schedule announced by the Chinese Communists. Earlier objectives were to produce 15 million tons of petroleum annually by 1967 and 40 to 45 million tons by 1972. The target dates recently have been moved forward several years. In fact, it has even been stated that the Chinese Communists are hopeful of achieving a 40-million-ton level by 1964. Such a claim may well be far too optimistic, but Communist China seems to be heading towards becoming the largest oil producer in the Far East.

Kansu Province is still the main producer of natural petroleum in the country. At the Yumen oil fields the new Ya-erh-chia formation is proving to be richer than the old Lao-chun-Miao formation; important discoveries also have been made at Paiyang-ho in the "Kansu Corridor." There is a 400,000-ton refinery at Yumen and a newly completed 1,000,000-ton refinery at Lanchow, between which a

The new Lanchow oil refinery.

548-mile pipeline is being built. Oil and gas resources of moderate significance have been discovered in the central part of Szechwan Province during 1958 and 1959, in Lung-nu-ssu—Nan-chung—Peng-lai area (oil), and at Huang-kua-shan (gas). A 20,000-ft well in Szechwan is the deepest drilled to date in Communist China. Construction has started on a 300,000-ton refinery at Nan-chung, and considerable quantities of crude are now being shipped to the greatly expanded Shanghai refinery, which is said to be as large as the Lanchow refinery. The Karamai oil field in Sinkiang, potentially the foremost field in the country, is proving much more extensive than first thought; much of the crude goes to the Tu-shan-tzu refinery (capacity before expansion was 500,000 tons per year) by double pipelines 92 miles long. Several other important oil fields in Sinkiang are now being developed. Promising oil and gas fields have been discovered in the Tsaidam Basin where a number of 100,000 to 250,000-ton per year refineries are already being built. All told, about 33 widely separated oil fields are known in Communist China, 14 having been fairly well outlined. The oil shale of Fushun, Manchuria, which is processed in Estonia, yielded perhaps 1.5 million tons of refined petroleum durng 1959 and represented a large part of the country's oil output. Many other extensive oil shale deposits exist, the most important being the undeveloped Mu-tan-chiang deposit in Heilungkiang Province and the producing Mow-ming deposit in Kwangtung Province. Communist China also is producing small quantities of synthetic oil from coal to meet the present petroleum shortage.

IRON AND STEEL

Communist China's iron ore base is proving to be much stronger than previously thought. The latest claim on potential reserves is a staggering 100 billion metric tons. Discounting exaggerations, the workable reserve appears to be at least 5 billion tons, more than ample to support a 50-million-ton steel industry. Ore quality and type vary greatly, but this poses no special technological difficulties. Iron ore, like coal, is widely distributed in Communist China; while details on deposit localities are not known, the iron and steel projects now planned imply iron ore concentrations in many parts of the country. Because of limited steel products in the past, iron ore should remain much more important than scrap for making steel.

Now the seventh largest world producer, Communist China has an expanding iron and steel industry, already about three-fourths that of Japan and several times that of India. Construction underway in Communist China shows that an annual steel capacity in excess of 20 million metric tons is definitely in the making. In fact, it would not be surprising if the country should produce 30 million tons of steel by 1965 and jump to fifth place among world producers. Present iron and steel smelting practices for the larger plants compare favorably with European and Japanese standards. However, fabrication lags a little behind steelmaking and a great deal behind pig iron smelting. The Chinese have mastered the techniques of building blast furnaces, open-hearth furnaces, converters, and electric furnaces, and are starting to manufacture blooming mills and rolling mills. The great import-

ance of large and medium scale iron and steel plants has been somewhat obscured by the publicity given to small plants and "backyard furnaces." The inefficient furnaces are being abandoned, and the so-called small plants are now being operated in a fairly systematic manner.

The special characteristics of Communist China's iron and steel industry help explain why the 1958 output and the 1959 targets were revised downward in August 1959. The original output claims for 1958 were 13.69 million metric tons of pig iron and 11.08 million tons of crude steel, and the revised claims, respectively 9.5 and 8 million tons; the differences between the higher and lower figures represent the quantities of inferior products produced by the small plants and "backyard furnaces." There is ample evidence that more than 12 million tons (1959 revised target) of good quality crude steel and 15 million tons of good quality pig iron were produced in 1959 in addition to several million tons each of off-grade products. In any evaluation of Chinese iron and steel statistics, the off-grade materials should not be ignored because they are satisfactory for making certain simple iron and steel products that do not require rigid specifications, and they also enter the resource reservoir of iron in use.

The fully integrated Anshan plant in Manchuria is still the backbone of the iron and steel industry of Communist China. Its tenth, and largest, blast furnace (about 45,000 cu ft in size with a daily capacity of approximately 2,500 metric tons of pig iron) and its 23d, 24th, and 25th open-hearth furnaces (500 to 600 tons of steel per heat) have recently gone into production. This steel complex will be expanded in the near future to about 6 million metric tons of iron and steel products yearly. Two important developments in the smelting practice at Anshan are that much oxygen is now used, and the "stomach" or hearth of the blast furnaces has been enlarged 25 pct with good results. Two other major iron and steel complexes to rival Anshan are in the making. The Wuhan iron and steel center in central China already has two large blast furnaces (about 40,000 cu ft in size), and three 500-ton open-hearth furnaces in operation (eight are planned). Two other blast furnaces as well as corresponding open-hearth furnaces and rolling mills are being built or are scheduled to be built. The Pao-t'ou iron and steel center in Inner Mongolia recently blew in its first large blast furnace (same size as the Anshan No. 10 furnace) as a start to becoming one of the "big three" complexes. Shangai has gained considerable stature as an iron and steel center in recent years; its current output of steel and steel products from a number of medium scale plants ranks second only to Anshan. About 15 other medium scale iron and steel plants (400,000 to 1,000,000 tons per year) and 25 smaller plants are being constructed in various parts of the country.

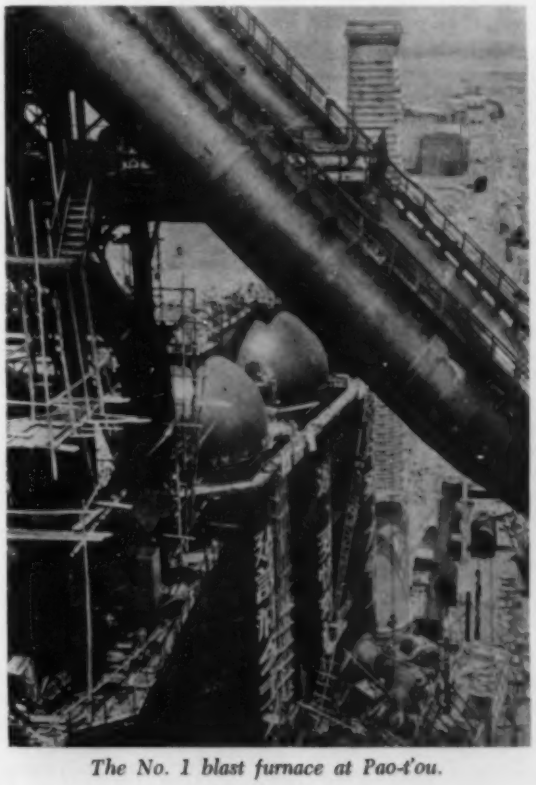
FERROALLOY MINERALS

Before the Communist era, almost all of the ferroalloy minerals produced in the country were exported. With the rapid expansion of the iron and steel industry, however, the overall picture has changed. Communist China is now making ferroalloys as well as special steels in electric furnaces. A one million-ton per year manganese ore industry is being developed which would be large enough not only to meet internal needs but also to allow some exports (e.g., Canada imported nearly 10,000 tons of manganese ore from Communist China in 1958). The Chinese apparently use much more manganese in steelmaking than western practice because of the greater availability of this material.

Chinese tungsten has long been famous in world markets; about 20,000 metric tons of 65 percent WO_3 concentrate is produced annually when demand is great and approximately 15,000 tons when demand is slack. Domestic consumption of tungsten concentrates may be approaching the level of 5,000 tons per year to meet the rising needs for cutting tools and drill bits. Already a medium-sized world producer of molybdenum concentrates, Communist China may become even more important in the future. Present output of molybdenum is primarily exported because of the large supply of tungsten which can be substituted for many of the molybdenum applications. The Chinese now make tungsten and molybdenum metal.

There is no indication that chromium or nickel ore of any consequence is being produced, for rising demands are met by imports. Communist China appears to require about 50,000 tons of chromite (partly in the form of equivalent ferrochrome) and several thousand tons of nickel (mainly as ferronickel) annually at the present. Refractory chrome needs are being substituted to some extent by domestic magnesia-alumina materials. There is no shortage of most minor ferroalloy minerals, such as titanium and vanadium.

Knowledge of Communist China's ferroalloy mineral reserve position is spotty. Manganese resources are extensive, probably on the order of 50 to 100 million metric tons. Most important high-grade deposits occur south of the Yangtze River, extending from Fukien Province westward through Kiangsi, Hunan, Kwangtung, Kwangsi, and Kweichow Prov-



The No. 1 blast furnace at Pao-t'ou.

inces. Some important low-grade deposits also have been found in the north. Tungsten deposits are much better known; in terms of 65 percent WO_3 concentrate the tungsten reserve is about 5.2 million metric tons. The four big mines—Hsi-hua-shan, Ta-chi-shan, Kwei-mei-shan, and Pan-ku-shan—in Kiangsi Province all produce wolframite. Kwangtung Province, also a producer of wolframite, ranks next to Kiangsi. Extensive reserves of scheelite exist, primarily in Hunan Province. Molybdenum is still a big question mark although the Chinese Communists have claimed the discovery of a very important deposit somewhere in the Chin-ling Mountains of Shensi Province. The mine that has furnished most of the country's past output is Yang-chia-chang-tzu, in Manchuria. A nickel copper deposit with reserves of perhaps 10,000 tons of nickel and 5,000 tons of copper is said to have been found at Li-ma-ho in Yunnan Province, along with several other nickel-cobalt occurrences of dubious value in various parts of the country. An intensive search for chrome is also being made but no significant discoveries are claimed.

NONFERROUS METALS

Mainland China's nonferrous metal industries (excluding light and precious metals) can be divided into two components, namely the nonferrous base metals (copper, lead, and zinc) and the nonferrous "export" metals (tin, antimony, mercury, bismuth, etc.). The Chinese have mined and processed copper and tin by primitive methods for thousands of years and have been familiar with native lead metallurgy and mercury metallurgy for many centuries. Knowledge of antimony stemmed from the World War I period; bismuth and zinc, from the World War II period. Production of base metals has been large by world standards for several decades.

For a long time, output of "export" metals was not only far greater in value than the output of base metals but also somewhat greater in tonnage. A radical change is taking place as a result of the industrialization program now underway. Despite production increases to significant levels, deficiencies in base metals still exist, particularly in regard to copper and in general to finished nonferrous items.

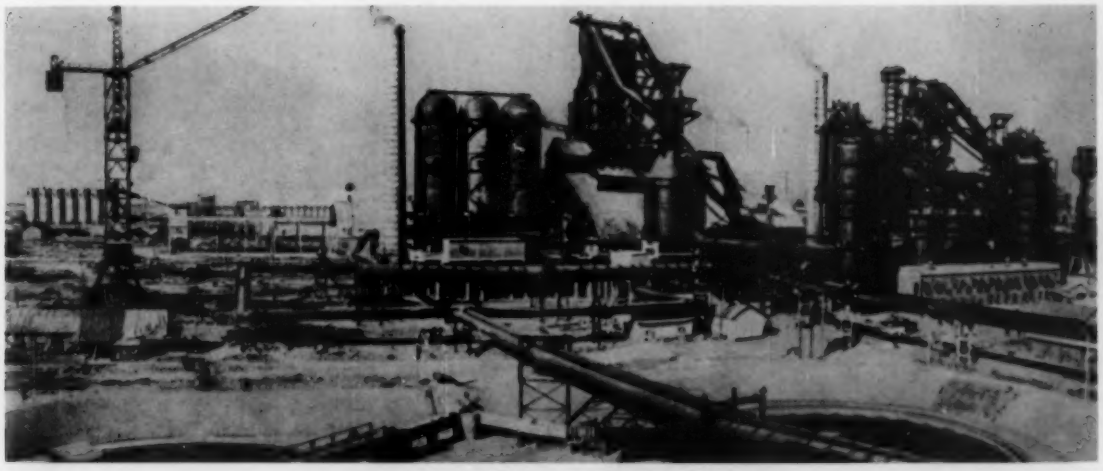
Communist China will become a medium world producer of nonferrous base metals within five years. Reserves of copper, lead, and zince have been reported at 3 to 6 million tons each and primary output for all three metals is expected to surpass 100,000 metric tons per annum by 1962 and 150,000 tons by 1965. Most nonferrous mines and smelters have a yearly capacity of 5,000 to 20,000 tons for the metals in question, not large by world standards but fairly up-to-date. The leading base metal smelters include Shenyang or Mukden (copper, lead, and byproduct zinc) and Hu-lu-tao (zinc and byproduct lead) in Manchuria, Shui-k' ou-shan (lead and zinc) in Hunan, T'ung-kuan-shan (copper) in Anhwei, Tung-ch'uan (copper) in Yunnan, and Shanghai (scrap metals). Most mines are not far from the smelters, except for the lead-zinc mines in Sinkiang which ship their concentrates to the USSR. New nonferrous base metal centers being developed include "Chung-t'iao-shan" (copper mine), the Sian area (copper-lead-zinc mine and smelter) in Shensi, Shao-kuan (copper-lead-zinc mine and smelter) in Kwangtung, T'ao-lin (lead-zinc mine) in Hunan, Sidin (lead-zinc mine) in Kwangsi, Hui-li (zinc) in Sikang, and at an unspecified location in Lianoning. Thus, Communist China's nonferrous base metal industries are rapidly being built up from a formerly insignificant base.

Tin heads the list of nonferrous export metals. Production in recent years has been about 67 pct more than the pre-Communist peak year. Reserves can support a 30,000-ton annual output indefinitely. A yearly surplus of approximately 20,000 metric tons of refined tin will exist for some years to come, part of which will continue to be absorbed by the Soviet Union and its European satellites. The Ku-chiu (primarily lode tin) area in Yunnan is still the backbone of the Chinese tin industry; much progress has been made in expanding facilities, streamlining operations, and making better grade products. The Fu-ho-chung (primarily placer tin) area in Kwangsi has become very important in tin production, ranking next to Ku-chiu. Fu-ho-chung tin is both extensive and clean. The Chinese antimony industry, still the largest in the world in terms of output and reserves, is not producing as much as in the past for lack of world markets. Hsi-k'uang-shan in Hunan still holds the position of the foremost antimony mine in the country. The mercury potential seems most promising, and Communist China's world position in this metal should improve in the future. Mercury deposits are wide-spread, the principal center of production at the present being the T'ungjen area, Kweichow. Output of bismuth, already large by world standards, can be increased should the export market become greater. Chinese bismuth occurs with tungsten and nonferrous metals. Refined bismuth is made at several refineries, but a large part of the bismuth is exported as concentrates.

LIGHT, PRECIOUS, AND MINOR METALS

Communist China has a small integrated aluminum industry, which is in the process of rapid expansion. Annual output of primary aluminum should top 100,000 metric tons by 1962 and 150,000 tons by 1965. Rolling capacity appears to be larger than primary output at the present. Demand greatly exceeds production now, necessitating large imports of aluminum ingots. The aluminum raw material base is strong in both resources and distribution. However, much ore is not adaptable to the conventional Bayer process; other processes are being investigated with fair success. From the long range viewpoint, power and non-aluminum materials for making aluminum are more than adequate. The rate of development of Communist China's aluminum industry will depend primarily on the construction of necessary facilities. The Fushun reduction plant in Manchuria and the Nan-ting alumina plant in Shantung are the most important producers at present. Two other large centers, both integrated, are being constructed in Sian (Shensi Province) and Kweiyang (Kweichow Province). Communist China should emerge as a medium-sized world producer of aluminum within five years.

Although there is hardly any information on magnesium extraction in Communist China, small quantities are probably produced, presumably at Ying-k'ou in Liaoning Province, Manchuria. There was a plant at this location during the Japanese occupation period which used sea water as well as magnesite for raw material. Magnesite resources in Manchuria are not only very extensive but of high purity. The Chinese Communists claim that they are capable of designing magnesium plants of 3,000-ton-per-year capacity. Apparently, the country is somewhat deficient in magnesium at the present.



The No. 2 blast furnace at Wuhan.

Communist China's gold resources are undetermined but believed to be extensive and widespread. Much placer gold exists, but the lode ores hold greater promise. While no statistics are available, the country probably is already a medium-sized world producer of gold. Future gold output will depend to a great extent on government policy since the tenor of Chinese ores does not seem to be particularly high. Silver is generally found and extracted with lead-zinc ores, and hence production most likely is not high. There appears to be a shortage of platinum, but deposits reportedly have been discovered in Tsinghai and Shensi Provinces.

Little is known about Communist China's resources and production of radioactive and related minerals. However, three general areas have been mentioned—Sinkiang, Kwangsi, and Liaoning. (At present, the only local market for radioactive material is the first atomic reactor in the country, a 100,000-kw research model completed in Peiping in June 1958.) The possibilities for vanadium appear to be good, and one producer is the Chinchou (or Chin Hsien) plant in Manchuria which draws its ores from Luan-p'ing and Ch'eng-te districts of Jehol Province. Some selenium, cadmium, germanium, and rare earth metals have also been produced, some on an experimental scale.

CHEMICAL MATERIALS

China had a small but fairly efficient chemical industry even before the Communists came into power. This industry has grown a great deal since that time, but it is still not important by world standards. As an indication of the magnitude of the inorganic chemical industry, Communist China produced about 900,000 metric tons of sulfuric acid, 750,000 tons of soda ash, and 300,000 tons of caustic soda in 1959. Output in these commodities should increase several times in the next three years.

Communist China already ranks second in the world as a salt producer. Most of the salt is used for food purposes, but industrial consumption is rising and a plentiful supply is available for making chemicals. The bulk of the salt is produced in coastal provinces by the evaporation of sea water, the largest fields being Ch'ang-lu in Hopeh and Ying-kai (Ying-k'ou and Kai-p'ing area) in Liaoning. In addition, many salt lakes exist in the inland areas of the northwest, and salt wells are found in the Tzu-liu-ching area of Szechwan not far from the newly discovered oil and gas fields.

Although showing promise, Comunist China's sulfur raw material base is not as strong as its salt base. Pyrite production is steadily rising, and the country will soon become an important world producer of this mineral. To supplement pyrite production from nonferrous mines (i.e., T'ung-kuan-shan, Shui-k'ou-shan, Tung-ch'uan, etc.), two large pyrite mines—Hsiang-shan in Anhwei and Ying-te in Kwangtung—are being developed. Some pyrite is used in making elemental sulfur, but most goes into sulfuric acid manufacture with byproduct pyrite cinder recovery. The story on native sulfur is still not clear. However, the country no longer suffers any deficiency in this mineral. More than 5,000 tons of sulfur have been shipped to the Soviet Union in each of the recent years, and exports have also been made to Poland and Australia, among other countries. One of the major sulfur producing areas is Szechwan Province, which reportedly makes shipments to eastern Siberia; another one is Shansi Province. In addition, fairly extensive deposits of gypsum in the vicinity of Taiyuan in Shansi Province can be used for their sulfur content if the justification arises.

Extensive phosphatic resources have been found in widesperad areas, primarily south of the Yangtze River but some in Shansi and Honan Provinces. These phosphate ores are not particularly high grade materials, and a fair amount is apatite that had not been domestically processed until recently. However, technology has advanced to the degree that off-grade and unconventional ores can now be handled. Consequently, while Communist China has relieved its shortage of phosphates in recent years by Moroccan imports, the supply situation is likely to improve as more mines are developed. The Chin-p'ing area in Kiangsu and the Kunming area in Yunnan are the largest producers at present. Large chemical phosphate centers are now being developed in Nanking, Taiyuan (Shansi), Kunming (Yunnan), K'un-yang (Yunnan), Kweiyang (Kweichow), Kaifeng (Honan), and Chan-chiang or Tsamkang (Kwangtung).

Natural nitrates in Communist China do not occur in large quantities, and small amounts have been

A small iron and steel plant at Yen-t'ai, Shantung Province.

imported from Chile. Most of the nitrogen is obtained by fixation. In 1958 large kainite resources were discovered in the Charhan Lake area of Tsaidam Basin in Tsinghai Province. It is being extracted and processed to provide China with a raw-material base for potassium fertilizers.

OTHER NONMETALLICS

Abundant resources of most refractories are found in the country. Chinese magnesite has long been world famous for its extensive reserves and high quality. The best magnesite deposits are located in the Hai-ch'eng—Kai-p'ing area in Liaoning Province, Manchuria. Communist China has had a surplus of calcined magnesia as well as magnesite for export. Reserves of aluminous materials suitable for making refractories are also extensive, and the Chinese Communists are making enough alumina for both aluminum reduction and refractory needs. In contrast, there is a shortage of refractory chromite. To compensate for this deficiency, a great deal of work has been done in substituting alumina for chromite in refractory bricks containing magnesia. Refractory grade silica and clay materials are also more than adequate to meet the needs of the Communist Chinese.

Aside from salt and magnesite, the country produces three other nonmetallics of great world significance, namely, fluorite, talc (and soapstone) and graphite (both crystalline and amorphous). All three are important export products, with fluorite and talc (mostly steatite grade) the better known in world markets. Domestic consumption of these minerals has arisen tremendously: fluorite as flux primarily in steel and aluminum manufacture; talc as filling material in the paper, paint and other industries; graphite for making crucibles, electric equipment, and pencils. The leading fluorite producing district is Wu-yi in Chekiang Province, followed possibly by the Kai-p'ing district in Liaoning and Lung-hua district in Jehol; fluorite is also mined in Shantung, Kwangtung, and Kwangsi Provinces. By far the most important talc and soapstone deposits are located in the Hai-ch'eng and Kai-p'ing districts of Liaoning Province. However, several new talc areas have been reported including the Lu-ch'uan deposit in Kwangsi Province. Graphite occurs primarily in Manchuria, Suiyuan, and Shansi. The leading graphite producing areas in the country probably include Liu-mao (or Chining) and P'an-shih (Kirin Province) in Manchuria, Hsing-ho and Wuyuan in Suiyuan, Tatung (Ta-t'ung) in Shansi, and Nan-shu (location unknown).

The Chinese Communists have developed several other nonmetallic industries to sizable proportions during recent years. A new town by the name of *Shih-mien* (meaning *asbestos* in Chinese) has sprung up near Lai-yuan, Szechwan Province. Shih-mien a very extensive deposit and the principal asbestos mine in the country, has transformed Communist China into a fairly important world producer of both long and short fiber crysotile asbestos. The mine at Shih-mien probably can support an annual output of 50,000 tons or more. Asbestos deposits and plants also exist in other parts of the country, and the mineral is used increasingly in the metallurgical and construction industries.

Communist China needs a great deal of barite in oil drilling. Although little data are available on deposits (located in Hopei, Honan, Shantung, Kwangtung, and Kwangso Provinces), the country has been changed from a status of deficiency to one of adequacy and possibly surplus in barite production. Important industrial diamond deposits have been discovered in Hunan, Kweichow, and Shantung Provinces; the first and probably the largest industrial diamond mine is Chang-te in Hunan. Significant quantities of this mineral have so far been imported to meet the needs of the country's drilling program, but adequate domestic supplies should soon become available. Much block and scrap mica resources have also been uncovered and sufficient amounts are now produced for use by the electrical industry. The Tukueiula mica mine (exact location unknown) in Inner Mongolia is probably the leading producer. Piezoelectric quartz is another new product, which is receiving some attention as an export item to the Soviet Union.

DEVELOPMENT OF A THERMOADHESIVE METHOD FOR DRY SEPARATION OF MINERALS

by R. J. BRISON and O. F. TANGEL

The development of a new method of mineral separation was sponsored by the International Salt Company, which requested Battelle Institute to investigate means for improving the quality and appearance of rock salt from the Company's Detroit mine. Although developed specifically for removing impurities from rock salt, the general method may be applicable to other separation problems.

The principal impurities in rock salt from the Detroit mine are dolomite and anhydrite which represent 2 to 5 pct of the weight of the mined salt. In the size range from ¼ to ½ in. (the range of primary interest in this project) the impurities are only partially liberated from the halite in normal production. Further size reduction to improve the liberation of impurities is not practicable in view of the market requirements for the coarse grades of rock salt. Laboratory separations in heavy liquids showed that, to improve the quality and appearance of the rock salt substantially, it would be necessary to remove not only free gangue particles but also a large proportion of the locked-in particles.

Because rock salt is an inexpensive commodity, a low-cost process was required. Gravity methods were, of course, considered. The heavy-liquid separations indicated that a split at an effective specific gravity of 2.2 to 2.3 would be required. (The specific gravity of pure halite is 2.16.) Heavy-media separation was investigated but had the disadvantages that it was necessary both to operate with saturated brine and to dry the cleaned salt, and that the cleaned salt was darkened by the magnetite medium. Air tabling was tried but did not give the desired separation. It soon became apparent that established methods would not provide a satisfactory solution and work was undertaken on the development of a new process to solve the problem.

PROCESS DEVELOPMENT

Preliminary Experiments: At the start of the investigation, an analysis of the problem indicated that the diathermacy of rock salt—that is, *its ability to transmit radiant heat*—might form the basis for an efficient separation process. Under this theory, the impurities might be selectively heated by radiant heat. The particles could then be fed over a belt coated with a heat-sensitive substance so that the warm impure particles would adhere preferentially to the coating.

After the initial experiments, made by heating the rock salt with an infrared lamp and separating the product on small sheets of resin-coated rubber, proved encouraging, a small continuous separation unit was set up. This comprised 1) a simple heating unit consisting of a vibrating feeder covered with aluminum foil and an infrared lamp mounted above the feeder and 2) a separation belt 6 in. wide and 36 in. long. A sketch of the device is shown in Fig. 1. Results with this apparatus confirmed the fact that a good separation was possible. It was apparent, however, that a considerable amount of experimental work would be needed to develop the scheme to a practical and economical process.

The Process: Basically, the process consists of two main steps: 1) selective heating by radiation and 2) separation of the heated particles on a heat-sensitive surface. Because neither of these steps had previously been utilized commercially in mineral processing, it was necessary to do basic research on both aspects.

Factors studied in the investigation included type of heat source, design of heating unit, design of separation belt, selection of heat-sensitive coating, removal of heated particles from the belt, contact between particles and coating, and maintenance of the heat-sensitive surface. Part of the experimental work was carried out on a small-scale unit consisting of the 36x6 in. belt and auxiliary apparatus, and part on a larger unit. For simplicity, discussion of work on both of these units is grouped together.

SELECTIVE HEATING

Radiant-Heat Source: The essential requirements for a radiant-heat source were 1) that the radiant heat be in a wave length range which is effectively absorbed by the impurities but not absorbed appreciably by the rock salt and 2) that it be dependable, practical, and economical.

Selection of a heat source of suitable wave length range was one of the first considerations. It is well known that pure halite is highly transparent to radiant energy in wave lengths from 0.3 to 13 microns. However, the available data on infrared transmission by dolomite and anhydrite, particularly in the range below two microns, were not complete enough to serve as a reliable basis for selection of a heat source.

Although it may have been possible to obtain sufficient data on infrared transmission and absorption to enable one to select the best heat source, a more direct procedure was used. This consisted simply of exposing the crude rock salt to each of several types of radiant-heat source on the small continuous separation device. The heat sources investigated, approximate source temperature used, and calculated wave length of maximum radiation are tabulated in Table I.

Of the two types of tungsten-filament lamps investigated, both the short wave length photoflood lamps and the longer wave length infrared lamps were satisfactory from the standpoint of selectivity

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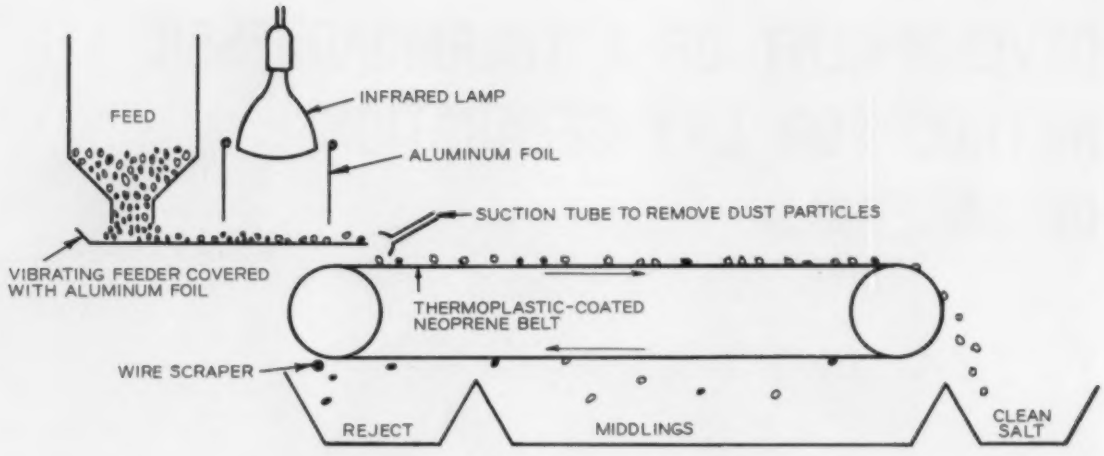

Fig. 1—Diagram of apparatus used in preliminary experiments.

in heating effect. However, the infrared lamps, having a lower filament temperature and consequently a much longer life, were superior from the cost standpoint. Because intensity of radiation is important, 500-watt standard industrial infrared lamps were selected.

The silicon carbide and the metal-sheathed heating elements were not as selective in their heating effect as were the tungsten-filament lamps. To explore the reason for this, infrared transmission spectrographs were made of two specimens of Detroit rock salt. These showed absorption at wave lengths of three and six microns, which coincide with absorption wave lengths of water. This suggested that finely disseminated water in the rock salt absorbs part of the radiant energy from the longer wave length sources and indirectly causes heating of the rock salt. In the case of tungsten-filament lamps, nearly all the radiation is shorter than three microns in wave length, so that the effect of heat absorption by water is negligible.

Heating-Unit Design: After selection of the high-wattage infrared lamp as a suitable heat source, the next step was to develop an effective means for exposing the rock salt to the radiant heat. The basic requirements of this step were considered to be as follows:

1) Uniform exposure of the crude salt to the radiation.
2) Maximum utilization of the available radiant heat.
3) Control of heat transfer by conduction.

The control of heat transfer by conduction perhaps requires some explanation. For the most part, it is obviously desirable to avoid thermal conduction as much as possible, both between the heated and unheated particles and between the particles and the equipment. However, it is necessary to allow a certain minimum time for thermal conduction so that the heat from inclusions of gangue in any particle will be distributed throughout that particle. Although not an essential requirement, it is also desirable that the heating-unit design should incorporate means for elimination of any fines that may be produced in the heating process.

As the result of laboratory investigation of various devices, a satisfactory heating unit was developed which consisted of a panel of infrared lamps mounted inside a revolving screen. This type of heating unit satisfied the three basic requirements listed above, and it provided a convenient means for removal of fines. A retention time of about one minute in this unit was satisfactory from the standpoint of control of heat transfer by conduction.

SEPARATION

The next phase of the work was to develop a method for separation of the heated impure particles from the essentially unheated clean salt particles. The separation device in this case consisted basically of a conveyor belt coated with a thermoplastic resin.

Separation Belt: In the general design of the separation belt, the main requirements were found to be 1) adequate capacity, 2) adequate retention time on the belt, and 3) good contact between the particles and heat-sensitive coating.

Because it is essential to have not more than a single layer of particles on the belt, the required capacity determines the width and speed of the belt for a given particle size. The length is then established by the required retention time on the belt. A retention time of approximately one second was found adequate.

Table I. Radiant-Heat Source Data

Heat Source	Approximate Source Temperature, °C	Wave length* of Maximum Radiation, microns
Metal-sheathed heating element (Chromalox)	550	3.5
Silicon carbide rod (Globar)	1100	2.1
Tungsten-filament lamp, infrared type	2200	1.2
Tungsten-filament lamp, photoflood type	3000	0.9

*Calculated from the formula $L = \frac{2898}{K}$, where L is the wave length of maximum radiation and K is the source temperature in degrees Kelvin. L is an approximation since the formula is based on black-body radiation.

To minimize wobbling or rolling of particles on the belt surface and thereby improve contact between particles and coating, it was found desirable to feed the particles on to the belt over a curved chute which would accelerate the particles to the velocity of the belt, and to provide a smooth flat deck under the belt in place of the customary conveyor idlers.

For the belting material, Neoprene was selected because of its good resistance to heat and its resistance to most organic chemicals.

Heat-Sensitive Coating: Early in the developmental work, it became apparent that the most effective type of heat-sensitive material would be a low-melting thermoplastic resin having the following characteristics:

1) Be a nontacky flexible solid at ambient temperature.
2) Become tacky at a temperature only slightly above ambient temperature.
3) Remain tacky for a considerable range above ambient temperature.
4) Be inexpensive.

For the final evaluation of resin compositions, direct testing on actual separation units was found to be most satisfactory. However, for preliminary screening of various compositions, a method was developed for determining the probability that a particle at a given temperature would adhere sufficiently to the belt coating to cause the particle's rejection. A probability curve for a typical resin is shown in Fig. 3. For most of the other resins tested in this way, the shape of this curve was similar to that shown in Fig. 3 but displaced toward higher or lower temperatures, depending on the softening point of the resin involved. It may be noted from Fig. 3 that the temperature difference between no rejection and complete rejection is about 20°F. This is the approximate temperature differential required to effect a separation between two materials.

The heat-sensitive materials which were found most satisfactory are blends of low-molecular-weight polymerized styrene resins marketed under the trade name of "Piccolastic". This was one of the first types of resin used in this work. Although a number of other types and combinations were studied subsequently, none was found to be more effective for this specific application.

Removal of Heated Particles: For the heated particles to be separated from the unheated particles, it is necessary that they adhere sufficiently to the resin so that they are deflected downward from the normal trajectory on leaving the belt. An adjustable splitter then separates the heated from the unheated particles. It was found that, under good operating conditions, most of the heated particles are thrown from the belt by centrifugal force as they go around the head pulley. The few remaining reject particles are removed by a steel wire stretched across the width of the belt under the pulley.

Maintenance of Heat-Sensitive Surfaces: The major problem encountered in respect to the resin coating was in maintaining a uniformly heat-sensitive surface for long periods of time. Although a revolving brush was provided for removing loose dust from the belt to minimize contamination of the resin, it was found that a small amount of dust gradually became imbedded in the resin surface and reduced the effectiveness of the resin to the point where the heated particles eventually failed to adhere. It was therefore necessary to renew the resin surface periodically.

The method originally developed was to apply a relatively thick (⅛ in.) coating of resin by mechanically spreading a hot melt on the belt surface. During operation, a revolving wire brush was used on the underside of the belt to gradually abrade and remove the thin outer layer of contaminated

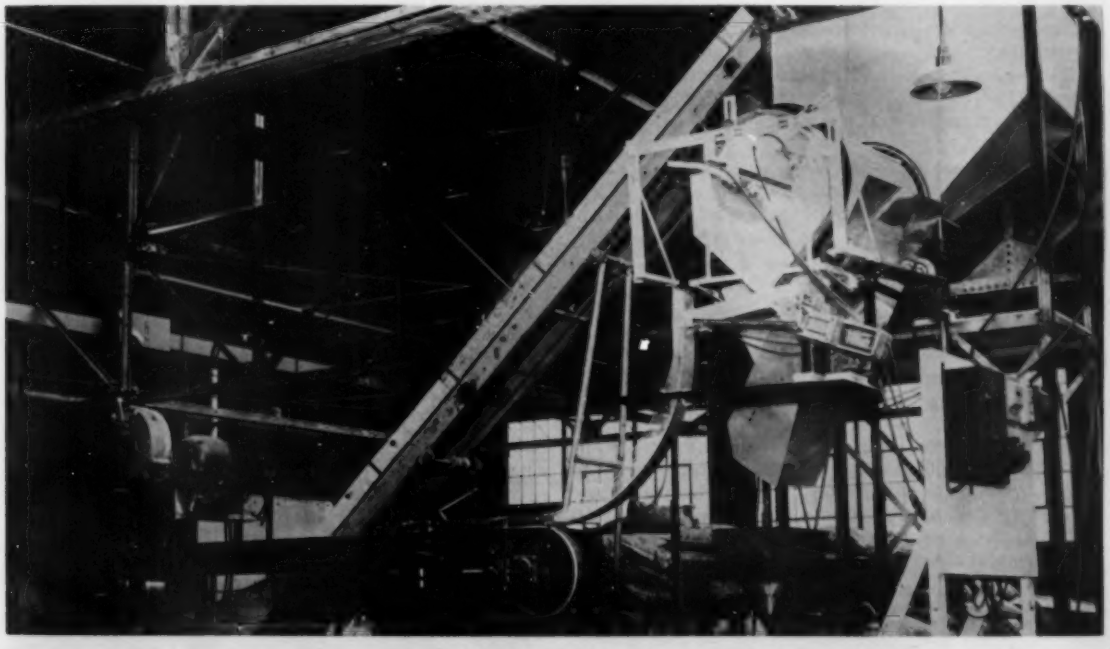

Fig. 2—View of the 1-tph pilot plant used by the Battelle Institute for the separation of impurities from rock salt.

resin. This method appeared satisfactory in the 1 tph pilot-plant operation, but in subsequent larger scale operation the method was not successful. The steel wires in the brush began to break after only a few hours of operation. This wire-brush problem probably could have been solved but a different approach to the basic problem of maintaining the resin surface appeared more promising. This approach consisted of the continuous application of new resin to the surface by spraying.

The main requirements for a spray-coating method were considered to be as follows:

1) The surface should be completely spray coated every 20 minutes or oftener without interruption of the separation process.
2) The resin should be applied in such a manner that the freshly applied resin would not cause rejection of unheated particles.
3) The resin should be applied in as thin a layer as possible to minimize resin consumption.

It was apparent that the first requirement could be met by having a spraying nozzle traverse the underside of the belt. To satisfy the second requirement, it was found necessary to avoid the use of solvents because even a trace of solvent remaining in the resin one second after application would cause undesired tackiness. The third requirement dictated the use of a low-capacity system capable of delivering a fine spray.

A spraying method was developed and tested on the 1 tph separation unit. It consisted of a pneumatic automizing spray with both air and resin preheated to about 400°F. Electric heating tape was used to prevent cooling of the resin in the air lines and in the nozzle.

A convenient method was also developed to remove periodically the excess resin which gradually built up on the belt. Radiant heaters were mounted near the belt at the head pulley to soften the resin while the belt was operated at reduced speed. The softened resin was then mechanically removed by a scraper. Although this operation involved stoppage of the feed to the belt, it appeared that it would require only a few minutes and would be necessary only once or twice in 24 hours of operation.

RESULTS

Typical results of pilot-plant separations are shown in Table II. Because of the incomplete liberation of impurities from the rock salt, the separation data alone do not give an adequate picture. Therefore, following each separation, there is shown for comparison the results of a heavy-liquid separation on a similar material at a specific gravity which gave approximately the same grade of cleaned salt. Although the heavy-liquid separations and the pilot-plant runs were not made on duplicate samples, the samples are believed sufficiently similar to give a fair comparison. For a cleaned salt grade of slightly over 98.0 pct, the pilot-plant recovery was only 1 to 2 pct less than that obtained with heavy liquids. In production of a grade of approximately 99.0 pct, the pilot-plant recovery was about 10 pct lower than the heavy-liquid recovery. This decrease in recovery is due to the fact that under the more intense heating conditions necessary to remove the slightly impure particles, some of the clean rock salt itself becomes heated sufficiently to be rejected. If desirable, sharper separations could undoubtedly

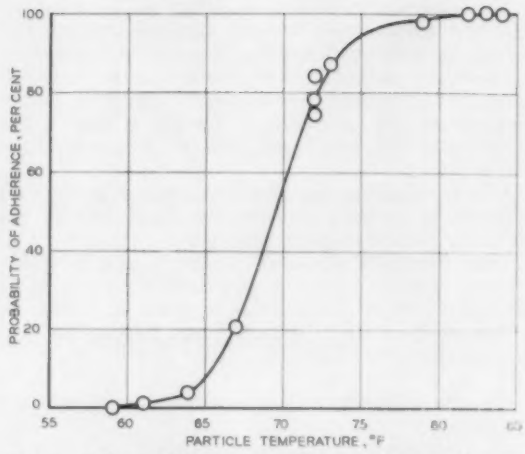

Fig. 3—Relationship between the temperature of a particle and the probability of adherence to belt coating treated with a typical resin compound.

be obtained by such means as retreatment of the reject or recirculation of a middling product, but the one-pass separations were considered satisfactory in this case.

It was found that increasing the quality to 98 pct NaCl resulted in a substantial improvement in appearance although some dark particles remained. Further increase in quality to 99 pct NaCl gave a white rock salt product comparable in appearance to the best rock salt obtainable from this source by laboratory separation in heavy liquids.

Although most of the work was done on rock salt from approximately ¼ in. to ½ in. size, separations were also made on material as fine as 10 mesh. However, since the capacity of a given size of separation belt is approximately proportional to the diameter of the feed particles, a relatively large belt area per

Table II. Pilot-Plant Separation Results

Separation	Product	Wt. pct	Analysis, pct NaCl	Distribution, pct NaCl	Distribution, pct Impurities
		No. 1 Rock Salt*			
Pilot-plant separation A	Cleaned salt	94.8	98.20	96.4	50.4
	Reject	5.2	67.77	3.6	49.6
	Composite	100.0	96.62	100.0	100.0
Heavy-liquid separation at 2.30 sp gr	Float 2.30	96.8	98.57	98.4	46.0
	Sink 2.30	3.2	47.02	1.6	54.0
	Composite	100.0	97.00	100.0	100.0
Pilot-plant separation B	Cleaned salt	84.5	98.55	86.0	33.6
	Reject	15.5	87.60	14.0	66.4
	Composite	100.0	97.11	100.0	100.0
Heavy-liquid separation at 2.20 sp gr	Float 2.20	93.0	99.04	95.0	29.7
	Sink 2.20	7.0	69.86	5.0	70.3
	Composite	100.0	97.00	100.0	100.0
		No. 2 Rock Salt*			
Pilot-plant separation A	Cleaned salt	93.9	98.34	95.9	42.4
	Reject	6.1	65.22	4.1	57.6
	Composite	100.0	96.32	100.0	100.0
Heavy-liquid separation at 2.30 sp gr	Float 2.30	94.3	98.15	97.1	37.4
	Sink 2.30	5.7	48.37	2.9	62.6
	Composite	100.0	95.33	100.0	100.0
Pilot-plant separation B	Cleaned salt	78.4	99.00	80.5	21.8
	Reject	21.6	87.00	19.5	78.2
	Composite	100.0	96.41	100.0	100.0
Heavy-liquid separation at 2.20 sp gr	Float 2.20	88.3	98.89	91.65	21.0
	Sink 2.20	11.7	68.35	8.35	79.0
	Composite	100.0	95.33	100.00	100.0

* No. 1 rock salt is 0.279 to 0.375 in. No. 2 rock salt is 0.375 to 0.500 in.

ton of feed would be required for particles as fine as 10 mesh, and the economics may consequently be unattractive in this size range for such an inexpensive material as rock salt. Furthermore, the —¼-in. grades of rock salt produced at the Detroit mine of International Salt Company are normally of sufficiently high purity that beneficiation is not required.

In regard to the size ranges above ½ in., no separations were made because normally all the rock salt is crushed through ½ in. However, it is believed that material at least as coarse as 1 in. could be satisfactorily treated, provided the degree of liberation was adequate.

OTHER POSSIBLE APPLICATIONS AND VARIATIONS

Although this paper has dealt with a very specific problem and the development of a process for its solution, the authors believe that this development may open the way to a number of practical processes not only for mineral separations, but also for separations of such diverse materials as chemicals, plastics, and metals, plus food and agricultural products. The method as developed for rock salt may, with modifications, be applicable to a variety of separations in which one or more of the components transmits or reflects radiant heat to a greater extent than do other components.

Radiant Heating Effect on Other Minerals: Qualitative studies have been made of the relative heating effect of infrared radiation from a tungsten-filament lamp on various mineral specimens. The results indicate that wide differences exist in the degree of absorption of the radiation by various minerals, but because of the effect of such factors as degree of crystallinity, purity, color, and specimen size, a tabulation of the individual results would be of limited value. In general, the strongly heated minerals include most sulfides and many dark-colored nonsulfides (e.g., graphite, chromite, cassiterite, tourmaline, biotite, wolframite, and fine-grained hematite). On the other hand, the relatively unheated minerals include those which, when present as coarse crystals, transmit much of the radiant heat (e.g., halite, sylvite, cryolite, fluorite, quartz, and calcite) as well as white, fine-grained minerals such as kaolin, trona, witherite, strontianite, bauxite, magnesite, amblygonite, and chalky calcite which reflect most of the radiation. These generalizations apply only to radiation from tungsten-filament infrared lamps.

Selection of Equipment: The type of heat source can be selected for any particular problem to give the optimum differential heating effect between 1) particles which absorb the radiant heat and 2) particles which either reflect or transmit the heat. Where economics justify it, filters might be used to confine the heat radiation to carefully selected wave length bands and thereby permit separations which might not be otherwise possible. A suitable filter might be one composed of the same substance as one of the materials to be separated.

Although conventional infrared lamps were found most effective in this application, potential radiant-heat sources for other applications include such types as new high-intensity quartz-tube infrared lamps and gas-fired radiant heaters.

The choice of heat-sensitive resin for a specific application will depend largely on the temperature of the feed material and the efficiency of separation required. In addition to the polymerized styrene resin, other types which are available include low-cost polymerized petroleum and terpene resins.

In regard to size of operation, possible applications of the process range from large-tonnage, low-cost operations employing cheap radiant heat and inexpensive resin compositions to small-tonnage, higher-cost operations on expensive materials.

Obviously, the feed material can be separated into more than two end products if required. This can be accomplished by various means such as the use of two or more separation belts in series and coated with different resins, or two or more splitters on the same separation belt.

Now that a practical means is available for effecting a separation on the basis of a small difference in temperature or heating effect, other related separation methods may become feasible. For conducting materials, induction heating may be used. Dielectric heating may be applicable in the case of some nonconductors. Separations based on differences in thermal conductivity (e.g., in recovery of diamonds) and differences in specific heat may be possible.

Because the process depends on minor differences in temperature, it is evident that, whenever practicable, the feed material should be delivered to the process at a reasonably uniform temperature. In the case described in this article this was not a problem because the plant was to be operated underground where the temperature is always constant. In other instances it may be necessary to bring the feed material to a uniform temperature prior to its being fed to the process. Any convenient temperature can be selected because suitable resin compositions are available for use at almost any temperature likely to be required. Furthermore, the feed temperature (and the resin) could be changed with the seasons if found desirable. Although it is considered desirable to maintain control over the ambient temperature, data obtained during the investigation indicated that the process is able to tolerate considerable variation in ambient temperature with no noticeable effect on the results obtained.

In cases where the feed temperature varies over a wide range and control of the feed temperature is impractical or expensive, the resin sprayed onto the belt may be automatically controlled to give the desired separation regardless of feed temperature. This system should accommodate any range of temperatures likely to be encountered, but it would still be desirable to have some provision to prevent abrupt changes in feed temperature.

ACKNOWLEDGMENTS

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The authors are indebted also to A. C. Richardson and others of the Battelle staff who contributed to this project.

BENEFICIATION OF ROCK SALT AT THE DETROIT MINE

MINERAL SEPARATION BY THE THERMOADHESIVE METHOD

by W. C. BLEIMEISTER and R. J. BRISON

The International Salt Company has long been interested in finding an efficient process for the removal of impurities from rock salt, and particularly from the rock salt produced at the Detroit mine. Methods which have been used previously at the Detroit mine included both hand sorting and differential crushing in a Bradford breaker with rejection of the oversize. Neither of these methods was adequately effective.

The development of a new process for removal of impurities from rock salt has been described in the preceding article.* Basically, the process consists of exposure of crude rock salt to radiant heating which selectively heats the impure particles. Subsequently the heated particles are removed by adhesion to a heat sensitive-coating on a conveyor belt. This method was found to be effective in improving both the quality and appearance of rock salt by the rejection of the dark, impure particles.

The first commercial unit employing the new thermoadhesive method of dry separation of minerals was installed at the Detroit mine of International Salt Company in Detroit, Mich. (Fig. 1). This unit was first put into operation in March 1957.

The purpose of the Detroit installation was 1) to serve as a pilot plant for evaluating the process on a commercial scale and 2) to produce marketable quantities of rock salt of improved quality and appearance. The design of this plant was based on the results and information obtained from a 1-tph pilot plant at Battelle Memorial Institute.

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DESCRIPTION OF PLANT

Location: The separation plant was installed underground near the crushing and screening plant, for this was the most suitable location from the standpoint of material handling. Furthermore, ample space was availabe at this location. Because the process requires a relatively constant temperature, the uniform year-around temperature of the mine (57°F) gave an added advantage to an underground operation.

Feeding: The rock salt is conveyed to a surge bin, from which it is fed to the heating unit by a conveyor. The feed-rate control consists simply of an adjustable gate at the bottom of the surge bin. The plant may be fed either No. 1 grade of rock salt (0.279 to 0.375 in.) or No. 2 grade (0.375 to 0.500 in.) with a maximum input capacity of 500 tons per 15-hour day.

Heating Unit: The heating unit (Fig. 2) consists of a panel of infrared lamps suspended inside a low-speed revolving screen. The radiant-heat panel, which is curved for most effective utilization of the heat, holds 240 infrared lamps of standard industrial type, each rated at 500 watts. The position of the panel is adjustable so that it can be placed centrally over and to within 6 in. of the salt bed on the screen. The entire heat panel is suspended by rollers in

* R. J. Brison and O. F. Tangel: *Development of a Thermoadhesive Method for Dry Separation of Minerals.*

such a way that it can be readily removed from the screen for maintenance.

The revolving drum-shaped screen is 24 ft long and 8 ft in diameter. It is of lightweight construction because only a small load of rock salt is on the unit at any specific moment. The screen cloth has ¼-in. openings, slightly smaller than that on which the salt is pre-screened. The size of the revolving screen was dictated by the necessity of having a sufficiently large area of rock salt exposed to the radiant heat, while at the same time, limiting the retention time to about one minute. The screen revolves at 2.7 rpm and has a slope of 2 in. per linear foot. Provision has been made to permit the adjustment of the slope of the screen to control the retention time if necessary.

Transfer Equipment: The function of the transfer equipment is to move the rock salt from the heating unit to the separation belt in such a way that:

1) the rock salt is uniformly distributed in a single layer on the belt,
2) the rock salt is accelerated to approximately the speed of the belt so that rolling of the particles on the belt is minimized, and
3) heat transfer is minimized.

The rock salt from the revolving screen is spread over the width of an oscillating feeder which distributes the particles across the top of a 10-ft-high acceleration chute. This chute is lined with stainless steel and is designed to accelerate the particles to the same velocity as the belt.

Separation Belt: The separation conveyor (Fig. 3) is 5 ft wide and 22 ft long when measured from the centers of the pulleys. It employs a Neoprene-covered belt which travels at 960 fpm. Between the

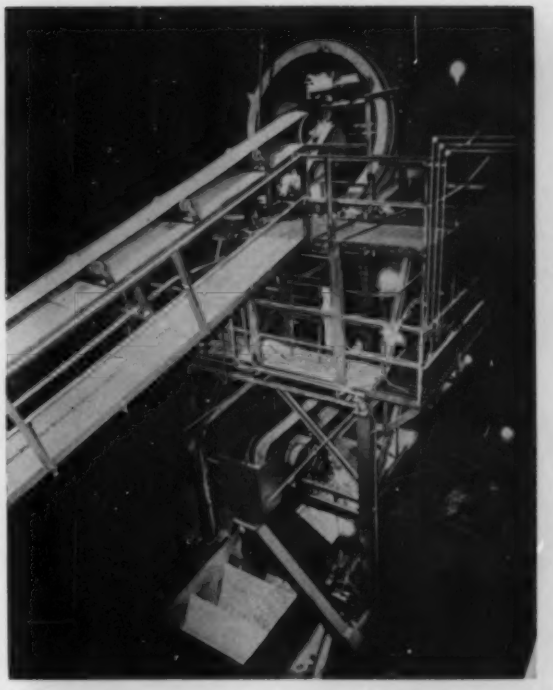


Fig. 1—General view of the separation unit at the Detroit mine of International Salt Company. The rock salt is introduced to the unit at top center of photograph via a conveyor belt (left). The cleaned salt discharge point is located in bottom center. From this point the cleaned salt product is transported to a bunker for storage.

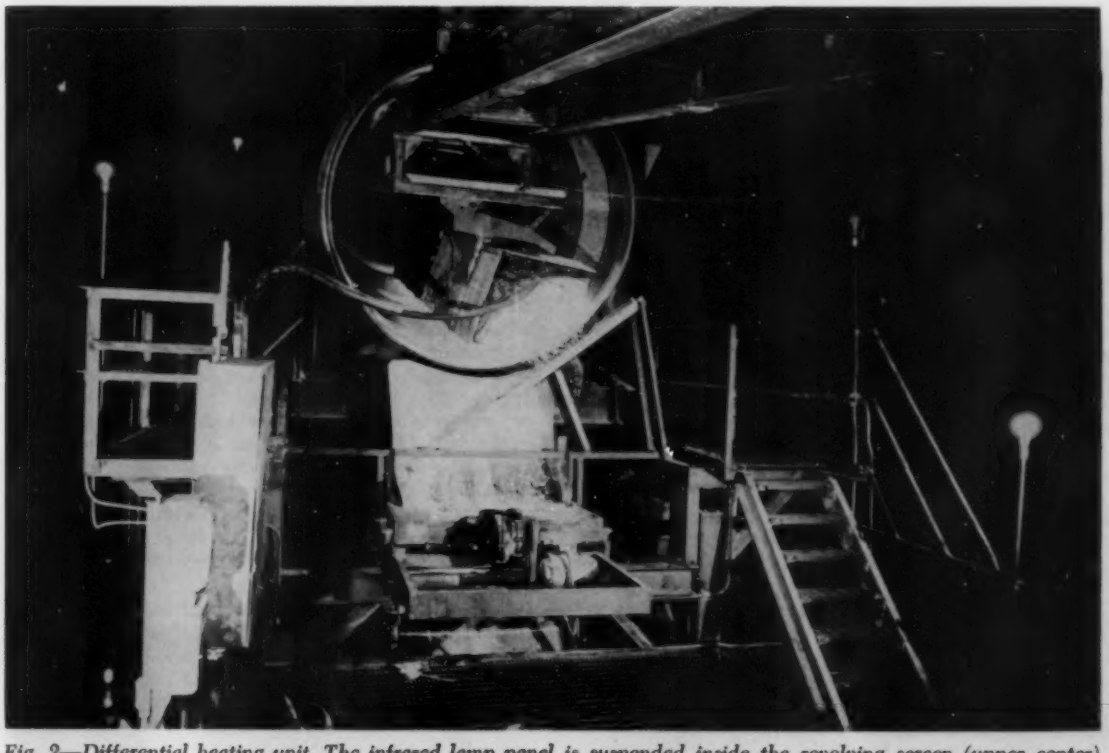


Fig. 2—Differential heating unit. The infrared lamp panel is suspended inside the revolving screen (upper center).

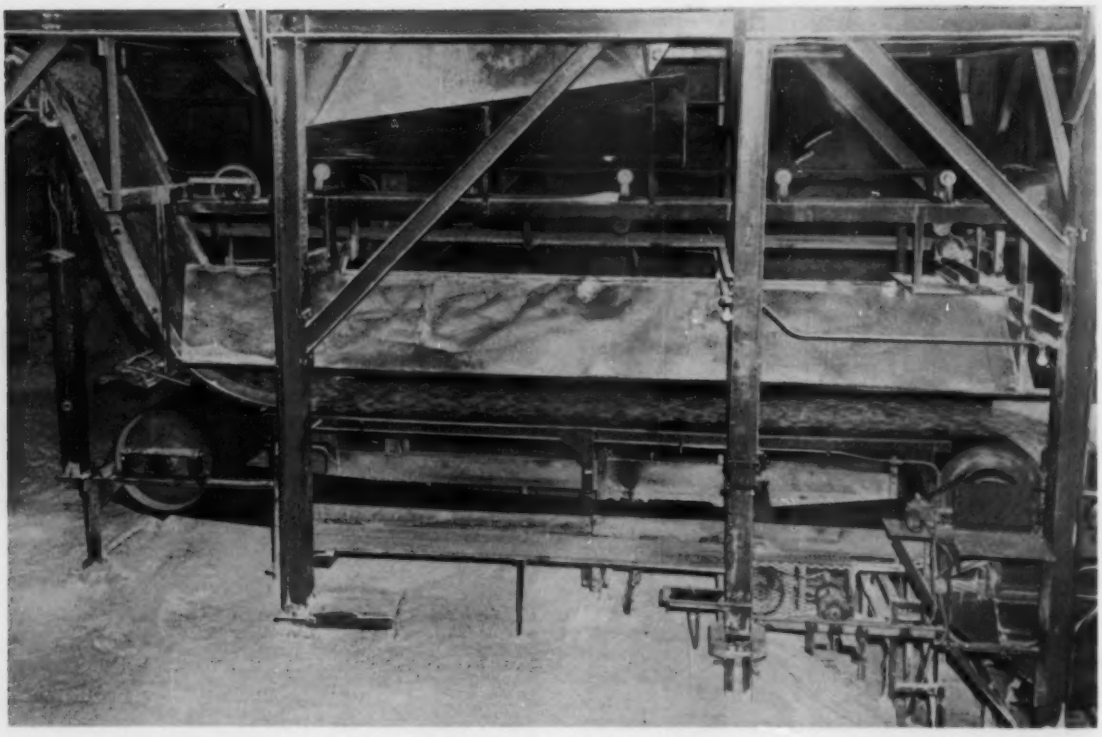


Fig. 3—Acceleration chute (left) and separation belt. Conveyor belt (arrow) above the separation belt removes fines from revolving screen. Shield above separation belt deflects falling particles which might interfere with process.

pulleys, the belt is supported on a sheet-steel deck rather than on rolls in order to eliminate vertical motion of the belt. Because of the light load on the belt, friction between the belt and the underlying steel plate is negligible.

The heat-sensitive resin employed is a mixture of polymerized styrene resins, Piccolastic A-25 and Piccolastic A-50. The proportion of each is adjusted to give the required softening point for attainment of optimum results.

The resin is applied continuously to the belt by a hot pneumatic spray from a nozzle which traverses across the underside of the conveyor. Each section of the belt is coated once every seven minutes. Because a very thin layer of resin is applied on each pass, the resin consumption is only about 3 lbs per hour, or approximately 0.1 lb per ton of cleaned salt produced in this process.

The particles remain on the belt 1.2 seconds. The relatively clean, unheated particles are then discharged in a normal trajectory from the belt. The heated particles which adhere to the heat-sensitive coating are deflected downward, and most of them are thrown off the belt by centrifugal force while going around the head pulley. However, those particles which still adhere to the belt (most of which are almost pure gangue particles) are removed by two wires stretched across the underside of the head pulley. Two wires are required because of the slight crown of the pulley.

At the end of the separation belt, an adjustable splitter separates the clean salt from the reject. The clean salt is conveyed to a bunker for storage, and the reject in conveyed to a bin from which it is periodically removed by truck.

A revolving nylon brush located on the under side of the conveyor is used to remove dust from the belt surface, thus minimizing contamination of the resin. A roll is used above the brush to prevent flapping of the belt at this point.

Because the resin layer on the belt gradually builds up in thickness, the layer must be removed after about 15 hours of operation. To do this, the belt is operated in reverse at slow speed by a separate drive. The resin is then heated to its melting point by a radiant heat panel as it passes around the pulley and is mechanically removed by a scraper. Dressing of the belt in this manner requires approximately 15 minutes.

PERFORMANCE

After construction of the plant was completed, an experimental program was run to establish operating conditions and to determine the separation results obtainable. The results of a typical series of experiments are shown in Table I.

The plant is flexible in that it can be adjusted to produce either a substantially improved rock salt (98 pct NaCl) with a high recovery of salt or, conversely, a higher quality rock salt (99 pct NaCl) at lower recovery. Fig. 4 shows the relationship between the quality of rock salt produced and the percentage recovery of salt. From this graph, it is evident that good recovery is obtained with a clean salt analysis of 98 pct NaCl, but that the salt recovery drops off sharply as the NaCl content of the cleaned salt product is increased to 99 pct.

It may be noted from Table I that, in this series, the feed rate was used as a means for controlling the radiant-heat input to the crude salt and thereby

controlling the quality of rock salt produced. Because this plant was designed to produce rock salt of 98 pct quality, it can be operated at its maximum capacity of 35 tph only when producing salt of this quality. Although some increase in quality is possible by the use of a resin with a slightly lower softening point, the production of 99 pct salt at a feed rate of 35 tph would probably necessitate a radiant-heat unit of higher capacity.

AUTOMATIC OPERATION

The feed rate to the plant, the softening point of the resin, and the adjustment of the splitter are the main points of control. Once adjusted to give the desired quality of separation, no further adjustment is generally required unless a change is made in product specifications.

Although these are the primary factors affecting quality control other factors which can have a bearing on the results are line voltage, condition of heat lamps, speed of separation belt in relation to speed of particles fed onto the belt, and resin spray operating conditions. However, these can be held sufficiently constant so that they do not cause significant variations in the results. In addition, the plant has been equipped with start-stop controls for automatic shut-down in case of feed interruption and automatic start-up when the feed resumes.

An indication of the basic simplicity of the process is that no operating labor is required even though this is the first commercial installation of its kind. The maintenance staff handles such matters as the daily dressing of the belt, the filling of the resin tank, and the weekly checking and replacing of heat lamps.

PROBLEMS

As would be expected in any new process, some difficulties were met in the initial testing and operation periods.

The major problem encountered was in maintaining a uniformly effective heat-sensitive surface on the belt coating. This difficulty arises from the fact that the resin surface is continuously being contaminated by dust particles. Although a revolving nylon brush removes most of the dust, a small amount becomes impregnated in the resin and eventually reduces the effectiveness of the heat-sensitive surface. The original method of maintaining the surface by means of a revolving wire brush was abandoned and laboratory work was undertaken to develop a better method. The development of the continuous spray method is described by Brison and Tangel in the preceding article. This spray method for maintaining the resin surface has been entirely satisfactory.

Other difficulties were overcome by various minor refinements in the plant such as 1) adjustment of the position of the lamp panel, 2) lining of the acceleration chute with stainless steel, and 3) adjustment of the belt speed.

Table 1. Typical Plant Results on No. 2 Rock Salt

Experiment	Feed Rate, tph	Product	Wt pct	Analysis*, pct		Distribution, pct	
				NaCl	Impurities	NaCl	Impurities
1	33.20	Cleaned salt	95.5	98.17	1.83	96.9	53.8
		Reject	4.5	66.70	33.30	3.1	46.2
		Calculated feed	100.0	96.75	3.25	100.0	100.0
		Analyzed feed		96.65	3.35		
2	25.79	Cleaned salt	91.1	98.30	1.70	92.9	42.7
		Reject	8.9	76.64	23.36	7.1	57.3
		Calculated feed	100.0	96.37	3.63	100.0	100.0
		Analyzed feed		96.44	3.56		
3	21.17	Cleaned salt	81.3	98.74	1.26	82.4	39.3
		Reject	18.7	91.54	8.46	17.6	60.7
		Calculated feed	100.0	97.40	2.60	100.0	100.0
		Analyzed feed		97.01	2.99		
4	15.31	Cleaned salt	61.1	99.09	0.91	62.5	17.4
		Reject	38.9	93.23	6.77	37.5	82.6
		Calculated feed	100.0	96.81	3.19	100.0	100.0
		Analyzed feed		96.87	3.13		

* Analyses are on a dry basis.

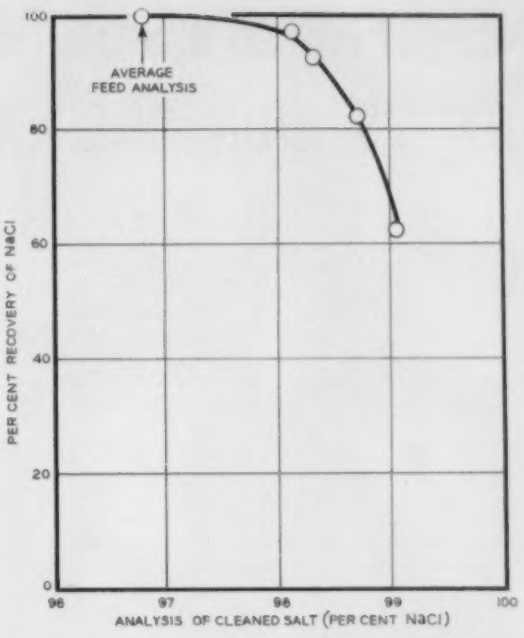


Fig. 4—Relation between the analysis of cleaned salt and the recovery of salt in the separation process.

COSTS

As an indication of the cost of the process, the approximate total cost per ton of beneficiated rock salt and the major cost items are listed below. These costs are based upon a daily 15-hour operation at a feed rate of 32 tph.

Cost Per Ton of Cleaned Rock Salt

Depreciation	$0.09
Maintenance	0.08
Electricity	0.06
Resin	0.03
Miscellaneous	0.07
Total	$0.33

ACKNOWLEDGMENT

The authors are indebted to International Salt Company for permission to publish this material. Much of the credit for success of the project belongs to the following International Salt Company personnel: D. W. Kaufmann, Development Engineer; Dr. Kurt Ladenburg, Director of Research; L. E. Read, Manager of the Detroit mine; R. W. Wade, Project Engineer; and F. W. Pfau, General Superintendent, Detroit mine.

The contributions of A. C. Richardson and O. F. Tangel of Battelle Memorial Institute are also gratefully acknowledged.

NEW FACILITIES ACCELERATE CHILE'S IRON ORE EXPORTS

Based on a report by A. T. YU

As the first year of full-scale shiploading operations nears completion, Chile's twin ports of Chañaral and Caldera have proved instrumental in promoting the growth of that nation's iron ore industry. Located on the *Iron Coast* several hundred miles below Antofagasta, the two ports boast of new conveyor shiploading facilities uniquely adapted to their coastal environment.

Until recently, iron ore producers in this region of Chile have been hampered by antiquated methods of loading crushed ore on ships for transportation to foreign buyers. Use of the "truck-to-lighter-to-ship" method, which dominated heretofore, was too slow and costly to permit expansion of productive mines and exploitation of new high-grade discoveries to meet the growing world demand for such ore.

To solve this problem, a relatively modest mechanized storage and shiploading system was conceived. The project was a coordinated effort by the staffs of the West South American Overseas Corp. of New York City, the Cia. Minera Santa Fe of Santiago, Chile, which is the largest iron ore producer in that country, and Hewitt-Robins Inc., Conn. Engineering, procurement, and construction were undertaken at record speed; shiploading towers at both ports were of identical design to facilitate construction.

A. T. YU is Director of Engineering, West South American Overseas Corp., New York City.

In June 1958, about one year after the start of construction, the first ship was loaded at Chañaral at the rate of 2000 tph. To accomodate further increased production from the mines in the Chañaral area, a 43,000-ton capacity live storage and tunnel reclaiming system went into operation at the beginning of 1959, and a 1000-tph railroad unloading system was completed last fall. At Caldera, for a variety of engineering and commercial reasons, the construction program was scheduled differently and this port did not commence operations until late 1958.

CHANARAL

The location selected for the loading facilities at Chañaral is a protruding point known as Roca Blanca, 200 miles below Antofagasta. Deep water for large ocean-going vessels is available as close as 200 ft from the coastline. The land portion of the area, however, is composed of barren granite forming steep, ragged slopes and cliffs. An optimum layout made efficient use of each square foot of available flatland and minimized costly blasting and rock excavation. The careful engineering and construction resulted in the modern and economic facilities now located at this site.

The initial installation completed in 1958 at Chañaral consisted essentially of 1) a 500-tph truck unloading and ore storage conveyor, and 2) an ore reclaiming and shiploading system.

Unloading Facilities: Conveyor No. 1, the so-called *stocking* conveyor, transports 8-in. run-of-

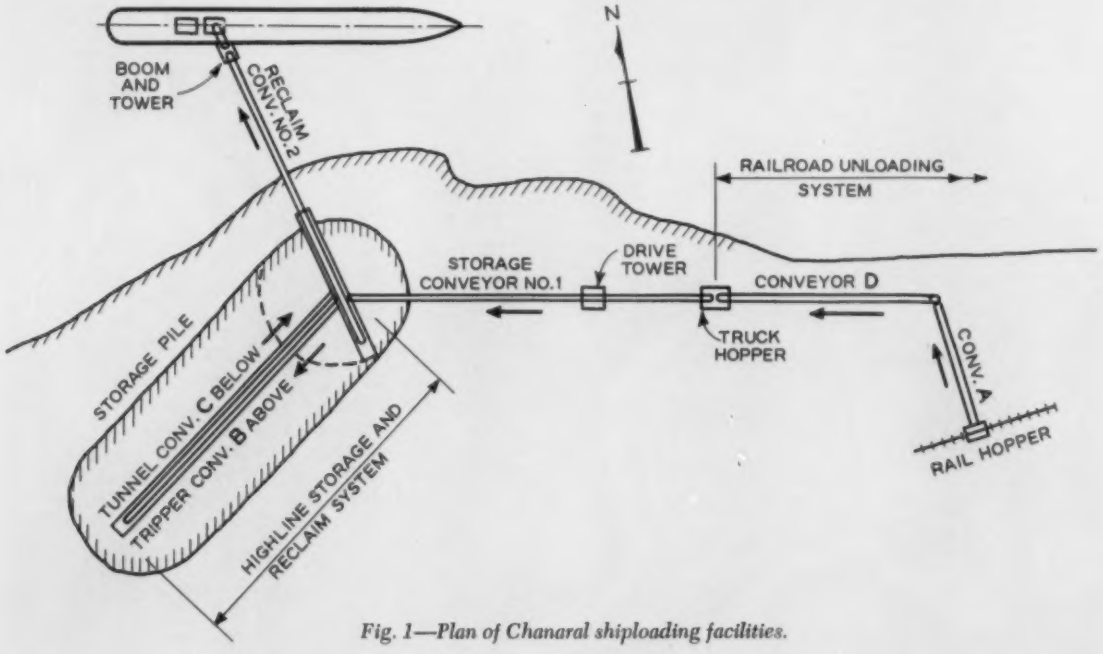


Fig. 1—Plan of Chanaral shiploading facilities.

mine iron ore from a truck hopper to a 27,000-ton capacity live storage pile at its head end (Fig. 1). This 36-in. conveyor is 600 ft long and has a rated maximum capacity of 1000 tph. For most of its length, the belt hugs barren rock slopes but its final section is supported by trusses and terminates 90 ft above the yard level at the head end. The conveyor is driven by a 75-hp motor with provisions for another identical drive to be installed on the opposite side of the belt when it becomes otherwise possible for the conveyor to attain its 1000-tph maximum capacity.

The first hopper constructed to feed conveyor No. 1 was designed to handle trucks with either rear dump or side dump unloading mechanisms. A 500-tph reciprocating pan feeder under the hopper regulates the feed of ore to the 36-in. belt. However, the possible substantial increased tonnage offered by the nearby railroad facilities of Andes Copper Co. warranted construction of a railroad siding and a double unloading hopper for the bottom-dump cars. One vibrating feeder was installed under each hopper, and through a series of chutes the feeders discharge jointly on to a 36-in. conveyor (*A*) at a rate of 1000 tph. This conveyor, 250 ft long and driven by a 15-hp motor, travels downhill, crosses the site of the future Pan American Highway, and extends to the coastline. At this point it unloads onto another 36-in. conveyor (*D*) which runs parallel to the coast. Conveyor *D*, powered by a 30-hp drive, travels about 390 ft to the immediate area of the truck hopper, where it unloads onto the slightly extended tail end of conveyor No. 1.

Shiploading System: From the conical stockpile at the head end of conveyor No. 1, a 42-in. tunnel conveyor (No. 2) reclaims the ore through the use of six manually operated hinged gates of the type often termed *ship-gates*. This conveyor is 425 ft long and is driven by a 200-hp motor. From the tunnel, this belt traverses a 180-ft long bridge and rises 43 ft in height to feed a 42-in. wide boom conveyor on the loading tower. The boom conveyor has a loading capacity of 2000 tph and is powered by a 50-hp motor. This conveyor operates in a range from $-16°$ to $+9°$ from the horizontal to trim the ships, but it can be raised to $+72°$ if necessary to clear a ship's bridge.

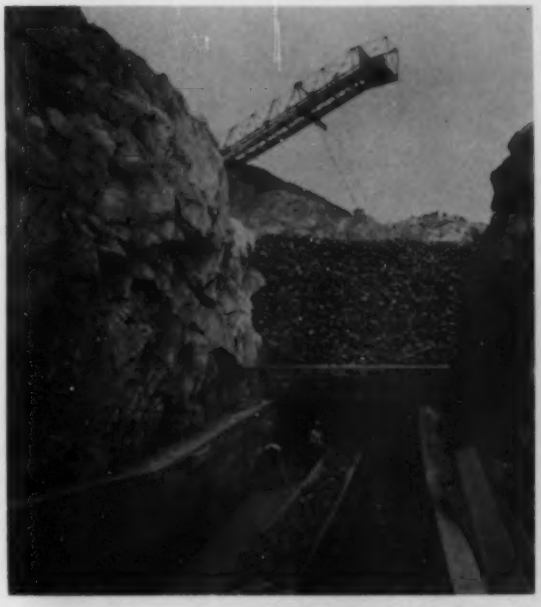


Fig. 3—Entrance of reclaiming tunnel at Chanaral. Head end of conveyor No. 1 looms over storage pile.

Fig. 2—Aerial view of Chanaral Port prior to completion of conveyor extension to railroad siding.

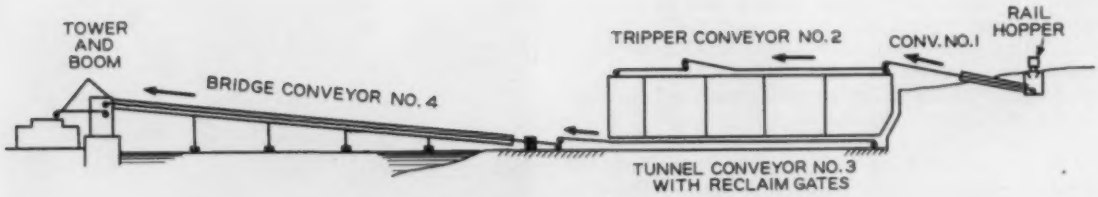


Fig. 4—Plan of Caldera shiploading facilities.

Highline Storage System: In addition to the storage pile at the head end of conveyor No. 1, substantially increased storage capacity is obtained by a highline tripper conveyor system at the west end of the port. Iron ore received by conveyor No. 1 is either stored in the pile previously described or is diverted through a chute to the tail end of the 42-in. tripper conveyor (*B*). Maximum travel of the tripper on the high bridge is 248 ft. Lump ore is stored in this area whereas fine ore is fed back on the belt and stored via a cantilevered boom in a separate pile. When desired the 42-in. tunnel conveyor (*C*), located under and along the pile, reclaims the ore and discharges it on to conveyor No. 2 for loading into ships.

Twelve ship-gates are installed on top of the reclaiming tunnel. Various grades of iron ore can then be stored and reclaimed separately. Various blends of ore can also be achieved by predetermined sequence of storing and reclaiming.

Live capacity of this storage is 43,000 tons of lump ore and 15,000 tons of fines. Total maximum amount of dead storage in the port can reach 120,000 tons when both storage piles are totaled.

CALDERA

In sharp contrast to Chañaral, the vast, relatively flat lands at Caldera yielded the simplest and most straight-forward "unloading-storage-reclaiming-shiploading" system one could readily envisage. On the other hand, because the very flat gradient extended out to sea, a 700-ft five-span trussed bridge had to be constructed to reach a water depth that could accommodate large ocean-going vessels.

The mechanized loading facilities at Caldera, 250 miles south of Antofagasta, was built and operated jointly by Sante Fe and Cerro Iman. The shiploading tower and 42-in. boom conveyor are identical to the installation at Chañaral. The reclaiming system consists of 1) a 450-ft long 42-in. tunnel conveyor fed by 21 manually operated ship-gates and 2) a 735-ft long 42-in. bridge conveyor to the shiploading tower (Fig. 6). The tunnel conveyor and bridge conveyor are powered by 100-hp and 200-hp drives respectively.

Unloading and Storage Facilities: A dual rail car unloading hopper receives iron ore from bottom dump cars, and dual reciprocating pan feeders collect and load the 210-ft 36-in. conveyor No. 1 at a rate of 1000 tph. This conveyor rises to height of 60 ft and feeds the 380-ft 36-in tripper conveyor No. 2. Iron ore can then be tripped off and stored anywhere along the tripper's 335 ft of travel. High concrete walls perpendicular to the centerline of the tripper conveyor divide ore storage into five compartments to accommodate different grades of ore.

SUMMARY

The new shiploading facilities have broken a major bottleneck in Chile's iron ore industry. It is expected that 4,500,000 tons of ore will be shipped from Chile in 1960 of which Santa Fe will contribute approximately three million tons of magnetite ore containing 60-69 pct Fe. Assuming favorable economic conditions, the loading conveyors will permit Chañaral and Caldera to handle further substantial increases in ore tonnage to be exported.

Fig. 5—Panoramic view of Caldera Port.

U. S. STRATEGIC MATERIALS STOCKPILES AND NATIONAL STRATEGY

by JOHN D. MORGAN, JR.

Uncertain world conditions of the present time require that this country be prepared to meet: 1) all out nuclear war with attack on the U. S.; 2) limited wars; 3) political, economic, and/or pyschological warfare.

Our present position as a major world power derives in large measure from our free institutions and great industrial productivity, and this productivity in turn depends on a continuing flow of raw materials—metals, minerals, fuels, and agricultural products. The U. S., with only about 6 pct of the world's population, uses from one to two thirds of the world's annual supplies of most metals and minerals. The U. S. strategic materials stockpiling program is designed to enhance our national security position: as stated in the preamble of the Stock Piling Act, to decrease and prevent wherever possible a dangerous and costly dependence upon foreign nations for supplies of strategic and critical materials in times of national emergency.

During World War I, U.S. and Allied production efforts were seriously hampered by shortages of strategic materials, and the final report of the War Industries Board recommended a U. S. stockpile of strategic materials. Nothing was done, however, until the war clouds gathered in the late 1930's, and it was only in 1939 that Congress passed the first Stock Piling Act. But shortages of both funds and materials inhibited acquisitions, and at the start of World War II there were insignificant quantities of most materials in the stockpile. Consequently, again in World War II U. S. and Allied production efforts were held back, allocation and limitation orders on materials were required, uneconomic forced-draft expansions of basic materials production had to be pushed, and our Armed Services had to divert major forces to the secondary mission of protecting far-flung import shipping lanes and overseas raw materials sources.

Having been twice caught with strategic materials shortages the U. S. finally learned its lesson, and in 1946 Congress passed the post-war Strategic and Critical Materials Stock Piling Act that has governed stockpiling ever since. The USSR, too, understands clearly the value of state commodity reserves in war, as has been testified to by Vosnesky, Chief of the Soviet State Planning Commission in World War II.

From the end of World War II to the start of the Korean War the stockpile was increased by transfers of war surplus materials and by new purchases, although transfers were limited by the competing demands of civilian production and new purchases by the funds available. In those days, moreover, some strategists argued that sole U. S. possession of nuclear weapons of mass destruction made conventional wars (and thus strategic materials stockpiles) obsolete.

A warning of economic warfare was sounded when the USSR, from which the U. S. had been obtaining more than one third of its chrome and about one third of its manganese, abruptly shut off shipments of these materials as a part of the intensification of the cold war following the Berlin crisis of 1948. But when the Korean War—a conventional one—started in mid-1950, the U. S. had on hand in its strategic stockpiles only about $1.6 billion worth of materials, compared to stockpile objectives of $4.1 billion. At the same time, accelerated defense production programs in the U. S. and abroad, together with scarce buying, hoarding, and speculation, reduced materials availabilities to the U. S. and sharply raised materials prices. Again the U. S. defense production effort was seriously hampered by materials shortages; priorities, allocations and limitation orders were again required; and respon-

J. D. MORGAN, JR., Member AIME, is a Consultant, Stuart, Fla. He was a member of the ODM Special Stockpile Advisory Committee and the NAS Committee on the Scope and Conduct of Materials Research.

sible defense mobilization officials became determined that this would not be allowed to happen in the future.

With the retreat of our forces in Korea in 1950, and the possibility that the conflict would spread, supply expansion programs were launched under the Stock Piling Act and under the new Defense Production Act and new accelerated tax amortization authority of 1950. These expansion programs were intended to increase domestic production, to stimulate needed production in strategically accessible sources, and to build up stockpiles. In the first few weeks after the start of the Korean War, Congress appropriated nearly $1.2 billion for stockpiling. However, copper, which had not been bought prior to the war at 16¢ per lb because of inadequate funds, soon rose to 36¢; tin, which had not been bought at 50¢ per lb, went up to $1.80; and tungsten, which had not been bought at $10 (ex duty) a unit, went up to $80. Prices of most other strategic materials also rose. The failure to build adequate stockpiles prior to the Korean War was revealed as dangerous to the national security and costly in money as well.

By means of accelerated tax amortization, contingent purchase contracts, and stockpile contracts in appropriate combinations, major expansions of metal and mineral production were stimulated in the years immediately after the start of the Korean War. For example, steel capacity, which had been about 90 million tons, was raised to about 125 million tons with assistance provided by accelerated tax amortization, and capacity now has been further expanded by private enterprise to about 149 million tons. Aluminum primary capacity, which had been about 800,000 tons, was raised to about 1.7 million tons through accelerated tax amortization and five-year contingent purchase contracts involving nearly $1.6 billion, and capacity has since been expanded to about 2.4 million tons by private enterprise. Perhaps the greatest proportionate expansion took place in the case of domestic tungsten mining which, under the stimulation of a guaranteed high price, rose from a low of about 3 million lb in 1949 to a high of nearly 16 million lb in 1955, or almost double U. S. industrial consumption. Supplies of almost every other strategic material were stimulated.

In 1950, 1951, and 1952 the increasing supplies were channeled mainly to current industrial consumption where most materials were needed for defense or defense-related production. Then, when the Korean War ended, defense production was cut back, but many mineral supplies continued to increase. For a while noncommercially marketable supplies flowed into both the strategic stockpiles and the Defense Production Act inventories rather freely, but gradually stockpile objectives were achieved. The Congress extended certain Defense Production Act purchase programs through the Domestic Minerals Program Extension Act of 1953 and then in 1956 launched the ill-fated Domestic Tungsten, Asbestos, Fluorspar, and Columbium-Tantalum Production and Purchase Act. Also in 1954, by the Agricultural Trade Development and Assistance Act, Congress created the Supplemental Stockpile of strategic and critical materials, a reserve intended to be above and beyond the regular strategic stockpile. Then, by the Agricultural Act of 1956, Congress permitted strategic and other materials obtained by the Commodity Credit Corporation as a result of barter or exchange of surplus agricultural commodities to be transferred to the supplemental stockpile and the CCC to be reimbursed therefor. Stocks accumulated under each different law must now be handled differently. For example, in normal times materials in the strategic stockpile generally cannot be disposed of (other than for obsolesence) without express approval of Congress, although they can be released by the President for purpose of the common defense. However, materials in the supplemental stockpile can be released only with the approval of Congress. But no such limitations apply to materials in the Defense Production Act inventories, which are now held off the market only as a matter of administrative policy.

As a result of activities under the various laws described above, the U. S. Government's strategic materials holdings (largely metals and minerals) as of Dec. 31, 1959, were as follows:

On hand toward Basic Stockpile Objectives	$2.3 billion
Additional on hand against Maximum Stockpile Objectives	2.0
So-called "Excess" of objectives	1.8
Supplemental Stockpile (on hand)	0.7
Defense Production Act Inventories (on hand)	0.9
Total	$7.7 billion

The tonnage of all strategic materials on hand is some 40 million tons, of which about 38 million tons are metals and minerals.

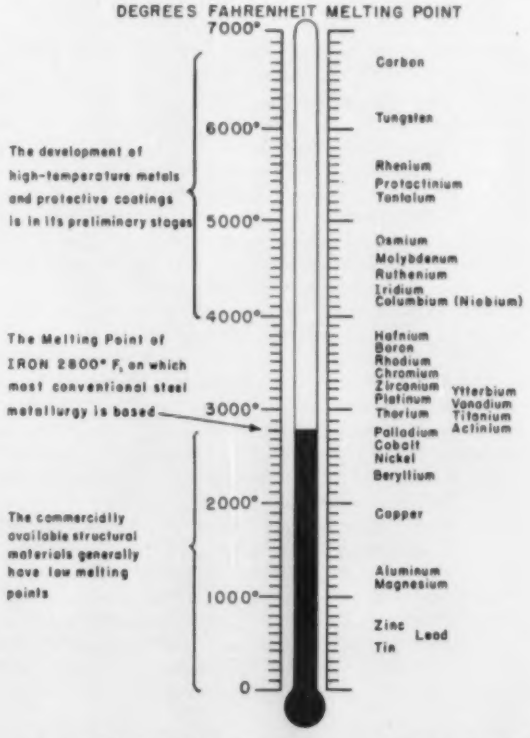


Fig. 1—Only a small number of elements have high melting points. This chart shows all known elements above iron and major metals melting at lower temperatures.

Fig. 2—View of a U. S. Government bauxite storage pile.

The so-called "excess" referred to above, to which must also be added the supplemental stockpile and much of the Defense Production Act inventories, results largely from the reduction in mid-1958 of the basic time period for stockpile planning from five years to three years. Also, in previous years there was a rule to the effect that stockpile objectives should be at least one year's normal U. S. use, and this too has been cut 50 pct. The cut from the five-year to the three-year basis was chiefly an economy measure, since it released cash formerly needed for new purchases and rendered more outstanding contracts subject to negotiated termination. In some quarters it raised the hope that major quantities of the so-called excesses could promptly be sold off in peacetime for cash that would be useful in reducing the increasing national debt. However, it is difficult to understand how any quantity can be officially labeled "excess" when the Government has not yet definitely determined either the requirements under conditions of nuclear attack or the need for materials in the recovery and rehabilitation period that would follow.

Although stockpiles of most commonly used industrial imported raw materials are now in good shape, there remains a very important area that requires further attention, namely, high-temperature and special-property materials, the use of which can be expected to increase sharply in military, atomic energy, space, and defense-related industrial production programs. Our various rocket and missile programs, our nuclear power plants, and our atomic powered planes and ships all require improved temperature-resistant materials to overcome the limitations of existing materials. Fig. 1 shows, however, that there are only a very limited number of elements which possess temperature-resistant properties, and most temperature-resistant compounds are made from one or more of these same elements. Of course, temperature-resistance is by no means the only property in which significant improvements must be made to permit the U. S. to stay in the forefront of the weapons and industrial technology race. Accordingly, stockpile objectives based only or largely on the past usage patterns cannot properly be expected to provide for future defense and emergency needs for new and improved materials in the high-temperature and special-property category. That more attention to basic materials research is required was revealed by the statement of the President of the National Academy of Sciences in the Spring of 1959 in appointing the special Committee on the Scope and Conduct of Materials Research. The Report of this Committee makes a number of administrative and substantive recommendations which, if effectively carried out, should considerably accelerate U. S. materials research, bringing about increased demand for high-temperature and other special-property materials as research results are translated into production programs. In this area, then, it is imperative that the Government try to assess the supply-demand situation for every potentially needed element or material for a period of five to ten or more years in the future, so that when they are available at reasonable prices these materials can be placed in a stockpile well in advance of acute need.

Stockpile objectives were previously determined by the Munitions Board of the Department of Defense and are now determined by the Office of Civil and Defense Mobilization in the Executive Office of the President, with advice from the several departments and agencies concerned, including the departments of Defense, State, Commerce, Interior, and Agriculture and the Atomic Energy Commission. As might be expected, the Department of the Interior provides much detailed advice on the basic metals and minerals, whereas the Department of Commerce provides information on the uses and supplies of many important metals and compounds. Stockpile objectives are generally computed by comparing estimated emergency requirements with estimated emergency supplies over a three-year period. Indicated deficits generally become stockpile objectives. Emergency requirements include military (army, navy, air force, marines), atomic energy, essential industrial, essential civilian, and essential exports (of either raw materials or finished articles). Emergency supplies include domestic mine production, recovery from scrap, reliable imports from

nearby sources, and reliable imports from distant sources. To arrive at estimates of reliable supplies, certain safety factors or discounts are applied to normal commercial supplies, based on advice of responsible government agencies. Since Basic Stockpile Objectives still assume some reliance on distant overseas sources, these are completed as quickly as possible. The larger Maximum Stockpile Objectives assume reliance only on nearby sources and domestic production, and once the basic objectives are achieved, increments toward maximum objectives are given lower priority.

Of the 75 materials now listed as strategic and critical for stockpiling, 59 are metals and minerals, ranging from antimony to zinc and including almost every imported material. Some metals and minerals are also stockpiled where the U.S. is normally considered self-sufficient, as in the case of molybdenum and vanadium, and some materials are stockpiled that are primarily manufactured articles such as synthetic abrasives, diamond dies, and jewel bearings, either because emergency requirements would be larger than normal supplies or because the processing facilities would be especially vulnerable. Not all the metals and minerals on the stockpile list are elegible for inclusion in the supplemental stockpile by the barter route, however, as additional considerations such as short-term commercial availabilities influence determination of the barter list. Also, only a limited number of the stockpiled metals and minerals are included in Defense Production Act inventories, but in some cases the DPA inventories include large quantities of a particular material in relation to normal consumption. Counting materials on hand in all inventories, 70 of the 75 basic stockpile objectives and 62 of the maximum objectives were on hand as of December 1959. Consequently new procurement is now limited to only a few items. The form in which materials are stockpiled varies. Some, such as manganese and chrome, have been stockpiled as manganese and chrome ore, as ferromanganese and ferrochrome, and as manganese metal and chromium metal. Others, such as copper, lead, zinc, and tin, are stockpiled almost wholly in ingots or bars. Some ores are upgraded to higher forms to offset especially vulnerable processing capacity, and so the stockpile contains compounds like tungsten carbide, ferro-vanadium, molybdic oxide, oxygen-free high-conductivity copper, and beryllium-copper master alloy. Naturally the upgraded forms represent more stockpiled power, transportation, facilities, manpower, and time—all likely to be in short supply in an emergency.

The relatively large stockpile inventories of many common imported materials offer the U.S. a better degree of protection than stockpiles at any time in our past. These inventories would be most valuable not only in a shooting war but also in the event that important foreign sources of raw materials were to be cut off by political or economic warfare or natural disasters. Nevertheless, questions keep coming up as to whether new techniques of warfare might make strategic materials stockpiles less useful. Accordingly, in 1957, the Director of the Office of Defense Mobilization appointed the high-level Special Stockpile Advisory Committee, composed of persons outside the Government. This Committee noted the generally satisfactory stockpile status of common imported industrial materials and recommended that emphasis now be shifted from raw materials to finished items and vital supplies for survival, relief, and rehabilitation in the event of nuclear attack. (Present civil defense stockpiles are now valued at only about $225 million.) The Committee also emphasized the need for establishing a mechanism to appraise the possible effects of research and development activities on requirements for high-temperature and special-property materials for the reasons already discussed at some length in an earlier paragraph of this article. The Committee noted that Government inventories of several materials already exceeded the three-year maximum stockpile objectives, but went on to point out that expansion of supplies of metals and minerals usually requires considerable time and major capital investment, that the storage of most metals and minerals is relatively inexpensive, that consumption thereof can be expected to increase rapidly with industrial expansion in the U.S. and abroad, that readily mineable domestic orebodies have been substantially depleted, and that the grade of many ores being mined domestically was declining. Consequently the Committee recommended that in the light of current world and domestic defense, political, and economic conditions all metals and minerals now in U.S. Government stocks suitable for use in normal commercial processes be retained unless required for use in the interest of national security.

However, the above recommendation as to retention has not been fully accepted by the Office of Civil and Defense Mobilization, which came into existence in mid-1958 through consolidation of the old Office of Defense Mobilization and the Federal Civil Defense Administration. In fact, in the latter part of 1959, the Office of Civil and Defense Mobilization served notice that it planned to ask Congress for revision of the several stockpiling laws to permit moving all materials in excess of the three-year maximum stockpile objectives into a new "reserve" stockpile, from which disposals could be made within a relatively short period unless Congress specifically rejected a disposal proposal (a much easier arrangement than the present requirement for express approval). While undoubtedly certain safeguards to protect normal business would be proposed for inclusion in the amended legislation, the contemplated sale of as much as $3 billion worth of strategic materials—not primarily for national security purposes but rather to redeem the investment in security—poses a real sword of Damocles over the world's mining industry. It is hoped that careful consideration will be given to the possible losses in tax revenues from U. S. citizens and companies, as well as the unfavorable impact on friendly foreign nations that look to raw materials sales as important sources of dollar income, before any large-scale peacetime sales of the so-called excesses is embarked upon. In fact, if there were broad understanding of the terrible possibilities of economic warfare on a wide scale, as well as the effects of long-term depletion of mineral orebodies coupled with rising demand for metals and minerals as the burgeoning world population tries everywhere to increase its standard of living, our concern for the long-term future of the U.S. as the primary bastion of the Free World should have us hard at work seeking to evaluate all the potential threats ahead, and adding to our national reserves of strategic materials while the time to do so is still in our favor.

SME BULLETIN BOARD

Reports of Your Technical Society

Rocky Mountain Minerals Conference, October 5, 6, 7

Newhouse Hotel, Salt Lake City

WEDNESDAY, OCT. 5—9:00 A.M. TO 12 NOON

Natural Gas Market in Utah by R. P. WORK, Mountain Fuel Supply Co.
The Sonic Resistivity Method of Log Interpretation by JOHN L. HALLMAN, Schlumberger Well Surveying Corp.
The Vicissitudes of Salt Production by LOCKWOOD W. FERRIS, Consulting Metallurgical Engineer.
Nuclear Reactors
I. *Atomic Power for Small Plants*
II. *Cost Considerations in Large Utility Applications* by E. L. KUNO, Westinghouse Electric Corp.

WEDNESDAY, OCT. 5—2:30 TO 5:00 P.M.

Geomechanics Laboratory at the University of Utah by JOHN E. WILLSON and JOHN R. HOSKINS, University of Utah.
Fluidized Bed Coal Dryer at U. S. Steel's Wellington Coal Drying Plant by W. L. McMORRIS, JR., U. S. Steel Corp.
Student Paper by University of Utah Student to be selected.

THURSDAY, OCT. 6—9:00 A.M. TO 12 NOON

Reagent Systems Design by J. D. VINCENT, American Smelting & Refining Co.
Electrolytic Tungsten and Molybdenum by D. H. BAKER, JR., and J. B. ZADRA, Reno Metallurgy Research Center, U. S. Bureau of Mines.
Role of Microorganisms in Leaching Processes by STAFF MEMBER, Kennecott Research Center.
The Vernal Phosphate Project of San Francisco Chemical Co. by D. L. KING, San Francisco Chemical Co.

THURSDAY, OCT. 6—2:30 TO 5:00 P.M.

Electric Wheel Truck at the Berkeley Pit by EDWARD R. BORCHERDT, Borcherdt and Smith.
The Silverton Project of Standard Metals Corporation by EDGAR T. HUNTER, Standard Metals Corp.
Mining the Sea Floor by L. E. SHAFFER, University of California.

FRIDAY, OCT. 7—9:00 A.M. TO 12 NOON

Exploration Symposium

FRANCIS CAMERON, St. Joseph Lead Co.
C. P. POLLOCK, American Smelting & Refining Co.
CHARLES C. HUSTON, C. C. Huston & Associates
FOURTH PANELIST TO BE SELECTED

FRIDAY, OCT. 7—AFTERNOON

Field trip to Bacchus plant (Minuteman missile research) of Hercules Powder Co.

(For further news of the Conference, see page 933.)

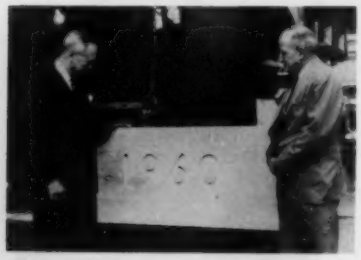
CORNERSTONE SET IN CEREMONY

Workmen poised atop the structural steel.

An historic moment was reached in the building of the new United Engineering Center, June 16, when former President Herbert Hoover and Mayor Robert F. Wagner helped set the cornerstone. The ceremony took place at 4:30 in the afternoon, with Andrew Fletcher, President of United Engineering Trustees Inc., presiding. Following the setting of the cornerstone, the Rev. Raymond H. Rosché, pastor of The Presbyterian Church of the Covenant, pronounced the benediction.

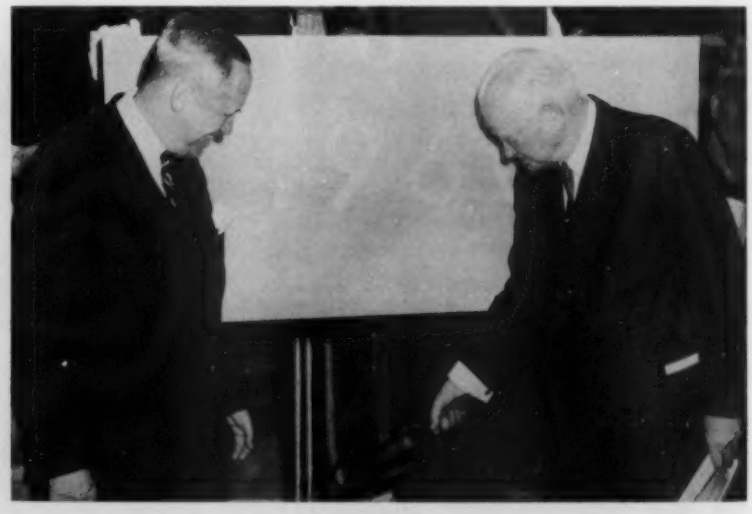
Mayor Wagner, delivering the principal address of the afternoon, stated: "In dedicating this cornerstone today we can contemplate the power, the integrity and the precision which dictates the determination of professionally trained engineers and we can afford to feel confident that our best interests are their primary concern. . . . It is my hope . . . that in cementing this symbolic stone we will have strengthened not only the foundation of a highly significant professional building but our healthy and dynamic society in which we have implicit confidence to surmount trouble and survive threat, not only during our times but beyond the distant future."

Following Mayor Wagner's address, Herbert Hoover read *A Message for Posterity*, which was deposited in the cornerstone vault. He included this tribute to the engineering profession: "During the last century our profession of engineering has advanced from the status of a trade to a great profession ranking with all other great professions. And with the training required for an engineer a great contribution for the future has come to the world. The very nature of training for our profession demands intellectual integrity and minds to whom truth has become an instinct. The leaven of this sort of mind will contribute to continuing progress in the free world."



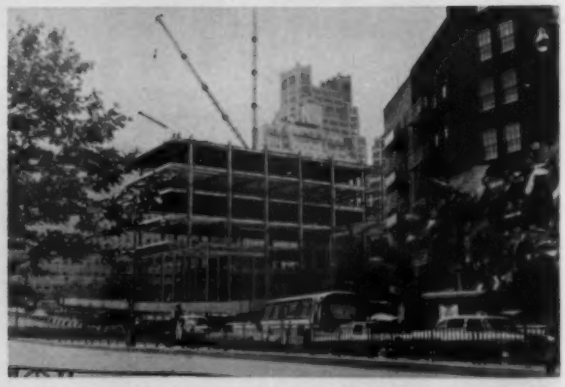
Andrew Fletcher and Joseph L. Gillson inspect cornerstone before ceremony.

Andrew Fletcher, left, watches as Herbert Hoover sets the cornerstone during ceremony.



Robert F. Wagner giving talk at ceremony.

George I. Brigden and Roger V. Pierce inspect building progress.



Work on new building continues amid rush of heavy traffic.

Announce Program for Solid Fuels Conference

The technical program to be presented at the 23rd Annual AIME-ASME Joint Solid Fuels Conference, which will be held October 24 and 25 at the Daniel Boone Hotel, Charleston, W. Va., was announced recently. There will be three sessions: one the morning of October 24, one in the afternoon, and the third the morning of October 25. A field trip is scheduled for that afternoon.

Session I

D. Davis, *Chairman*
A. Spotte, *Co-Chairman*

Mechanical Mining in Low Seam (28 to 36 in.) Mines: *Clyde Storey*, Princess Elkhorn Coal Div., Princess Coals Inc.

What Industrial Consumers Look for in Purchasing Coal: *Donald M. Given*, Union Carbide Corp.

The Supplier's Viewpoint in Selling Coal: *C. R. Mobley, Jr.*, Island Creek Coal Sales Co.

Session II

M. L. Jones, *Chairman*
R. W. Precious, *Co-chairman*

A Decade of Electric Utility Fuel Experience: *Myles E. Robinson*, National Coal Assn.

New Concepts—Coal from Mine to Industrial Boilers: *C. E. Day*, E. I. du Pont de Nemours & Co. Inc.

Session III

J. B. Walker, Jr., *Chairman*
H. C. Skaggs, Jr., *Co-chairman*

Volatile Matter in Coal and Its Relation to Pulverized Coal-Fired Units: *Joseph F. Mullen*, Pittston Clinchfield Coal Sales Co.

The Comparison of Sulfur Analyses by Combustion Tube and Eschka Methods Using Coals from Various Seams and of Varying Sulfur Content: *E. J. Sandy*, West Virginia University.

NCA Offers Aid to Iowa Governor in Coal Study

The National Coal Assn. offered its services to Gov. Herschel C. Loveless, who has appointed a special committee to survey the coal industry of Iowa. In a letter to the governor, NCA President Stephen F. Dunn wrote, "I would like to offer you my sincerest commendation on this very constructive move and assure you that the National Coal Association will be more than happy to assist you in every way possible."

W. E. Wrather Receives Honorary Membership

William E. Wrather was elected to Honorary Membership in AIME in 1959. Unfortunately, since he is incapacitated and spends his winters in Florida, he was unable to attend the Annual Meeting in February 1960 and to receive his Certificate of Honorary Membership at the Annual Banquet.

On June 3 President Gillson made a special trip to Washington, D. C., to call on his old friend and present the Certificate in person. On this occasion Dr. Thomas Nolan, Dr. Wrather's successor as Director of the U.S. Geological Survey, accompanied Dr. Gillson. The photograph below, taken at Dr. Wrather's home during the presentation, shows that although he is confined to a wheelchair Dr. Wrather still exhibits all his old sparkle, friendliness, and intelligence.

William E. Wrather is one of the outstanding elder statesmen of AIME.

Joseph E. Gillson, left, shown presenting a certificate of honorary membership in AIME to his old friend William E. Wrather at the latter's home in Washington, D. C.

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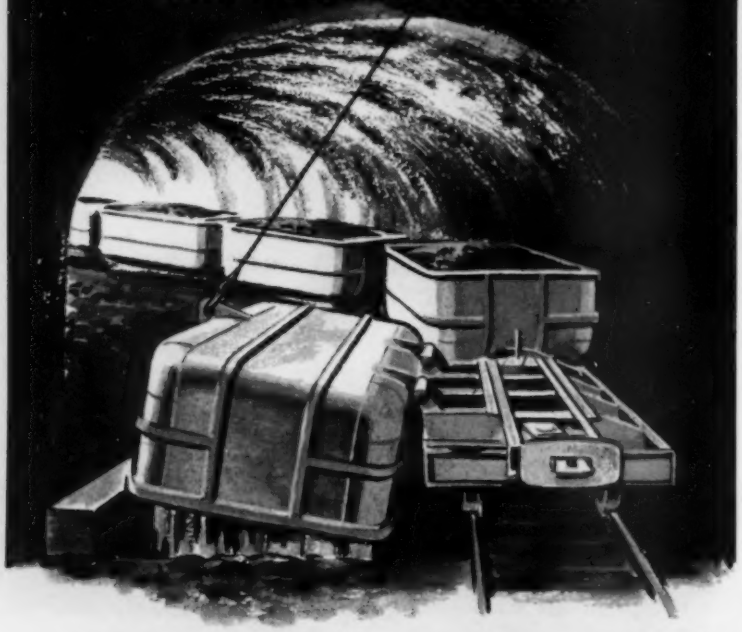

THE TOUGH ONES COME TO **Card**

Kermac Nuclear Fuels Corporation is operating four major wet mines in the Ambrosio Lake area of New Mexico. Slop-forming shale lenses interbedded in the ore help form a watery muck that flows easily when handled but sticks tightly to machinery, pockets and car bodies when allowed to settle. To solve this tough problem, Card furnished a string of 40 special "Telluride Type" cars that feature a solid body for side dumping and intense shaking. The cars range from 77 cu. ft. to 110 cu. ft. capacity.

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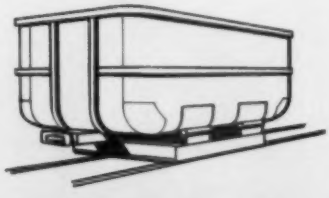

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St. Louis–SME Coal Div. Meeting Program Set

Only one major change has been made in the program of the Joint Conference of the AIME St. Louis Section and the SME Coal Division since the announcement of the preliminary program in June. *Stripping Machinery Mass, Overburden Volumes Relationships* by Henry Rumfelt will be substituted for W. A. Weimer's paper *The River King Mine and Mississippi Coal Loading Dock*. Registration begins 8:00 a.m. Thursday, September 8 at the Chase Park Plaza Hotel in St. Louis.

Thursday, September 8, AM

8:25-8:50

Authors' Breakfast

9:00-12:00

Technical Session

H. Eugene Mauck, *Chairman*

Shaft Sinking and Lining in Illinois Coal Fields: *J. W. MacDonald*, Old Ben Coal Corp.

The Winning of Fluorspar—Our Area's Most Strategic Mineral: *Gill Montgomery* and *Durward C. Spees*, Minerva Oil Co.

Stripping Machinery Mass, Overburden Volumes Relationships: *Henry Rumfelt*, Bucyrus-Erie Co.

Thursday, September 8, PM

12:15

Field Trips

Buses leave Chase Hotel for luncheon at Augustines in Belleville, Ill. Luncheon speaker: *L. S. Jewell*.

2:30

Buses leave restaurant for field trip to River King Mine and Mississippi River Dock.

7:00-7:30

Social Hour

7:30

Stag Dinner and Smoker

Speaker to be announced

Friday, September 9, AM

9:00

Technical Session

David H. Davis, *Chairman*

The Adaptability of Illinois Coals for use in Iron and Steel Production: *Hubert E. Risser*, Illinois Geological Survey.

Oklahoma-Arkansas Coals: B. L. *Curry*, Lone Star Steel Co.

Meramec Mining Company's Pea Ridge Project: *E. L. Bilheimer*, Meramec Mining Co.

(Continued on page 936)

ROCK IN THE BOX

Mining & Exploration Division

BIG PLANS FOR ROCKY MOUNTAIN MINERALS CONFERENCE

Plans for the sixth annual Rocky Mountain Minerals Conference, to be held in Salt Lake City October 5, 6, and 7, have been completed, according to recent word from J. M. Ehrhorn, head of the conference committee. Papers to be presented include a broad scope of subjects of current interest in the industry. Highlight of the discussions will be a symposium of exploration to be held the final day of the conference.

J. M. EHRHORN

MRS. A. J. THULI

Conference headquarters will be the Newhouse Hotel, where facilities for early registration will be available the afternoon of October 4. The conference will get under way the next morning when the first technical session begins.

In addition to technical sessions, events have been planned for the entertainment of both the men and their wives. Both are welcome to attend the field trip to the Hercules Powder plant in Bacchus, Utah; the dinner-dance on Friday night; the Welcoming Luncheon, the Minerals Luncheon, and the Miners Breakfast. Besides these joint activities, Mrs. A. J. Thuli, Ladies Event Chairman, reports that a welcoming coffee will be held at the Newhouse Hotel in conjunction with registration activities, as well as a special luncheon and fashion show at the Salt Lake Country Club.

Maxwell E. Rich, Adj. General of the Utah National Guard, will be the featured speaker at the welcoming luncheon and Joseph L. Gillson, AIME President, will be the guest speaker at the minerals luncheon. The traditional miners breakfast is planned for the closing day of the conference.

A highlight of the entertainment events will be a suppliers and miners cocktail party to be held at the Newhouse Hotel on the evening of the opening day of the conference. Mining companies, suppliers, and numerous businesses from Salt Lake City have combined their resources for this party, eliminating the need for host rooms for private parties during the conference.

Adolph Soderberg, program chairman, announced that most of the speakers have already indicated their acceptance and abstracts of all papers will be available by the time the conference opens. Papers scheduled for presentation include: *Natural Gas Market in Utah* by R. K. Work; *Sonic Resistivity Method of Log Interpretation* by J. L. Hallman, Jr.; *Fluidized Bed Coal Dryer* by W. L. Morris, Jr.; and *Geomechanics Laboratory at the University of Utah* by J. R. Hoskins and John E. Willson.

A member of the staff of Kennecott Research Center will present a paper entitled *Role of Microorganisms in Leaching Processes. Vicissitudes of Salt Production* will be the subject of Lockwood W. Ferris' talk, and Edward R. Borcherdt's will be *Electric Wheel Truck at the Berkeley Pit.*

The Silverton Project of Standard Metals Corp. will be presented by Russell L. Wood; *Mining the Sea Floor* by L. E. Shaffer; and *The Vernal Phosphate Project of San Francisco Chemical Co.* by D. L. King.

Papers will also be presented on reagent systems design, fused electrolysis, and cost factors in the choice of nuclear fuels vs other fuels in the utilities industries.

The Exploration Symposium will be held the morning of the final day and will cover ore search objectives; development of mines from ore search to production; costs of ore search; and ore search objectives, costs, and results in Canada. Among the speakers on the panel will be Francis Cameron, C. P. Pollock, and Charles C. Huston.

For last-minute program details of the technical sessions see SME Bulletin Board, page 929.

Utah Uranium Symposium

More than 500 people attended the fifth annual Uranium Symposium at Moab, Utah, May 6 through 8. Technical papers; geology, mining, and milling forums; field trips; ladies

(Continued on page 934)

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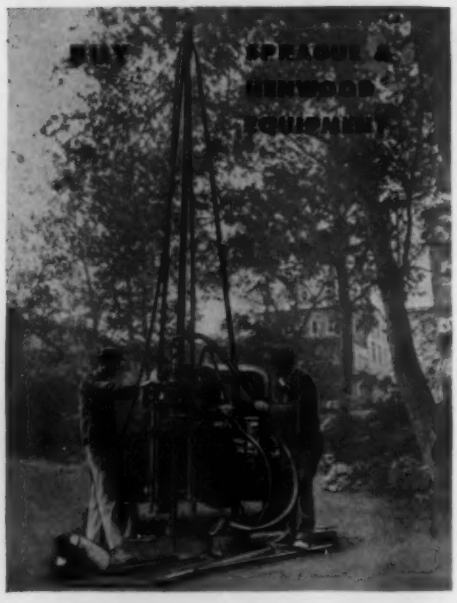

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Uranium Symposium

(Continued from page 933)

The Charles Steens, foreground, enjoying an informal moment during the banquet.

Rocket specialist John E. Greer addressing guests at Uranium Section Banquet.

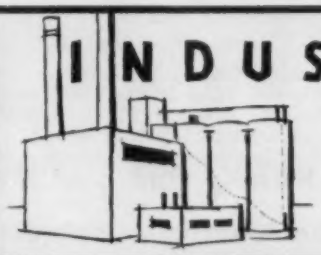
The Steen's pool served as focal point for the traditional chuck-wagon dinner.

events; and social activities, capped by the traditional chuck wagon supper at the home of Charles A. Steen, made for a crowded schedule in which facts and fun were happily blended.

John E. Greer, Hercules Powder Co., Bacchus, Utah, was after-dinner speaker at the banquet held May 7. His subject was *Guided Missiles—Problems, Projects and Developments.* Entertainment and dancing followed at the Towne and Country Club.

Guest speaker at the welcoming luncheon was Oscar A. Glaeser, president of the Utah Mining Assn. and vice president and general manager of western operations, U. S. Smelting Refining & Mining Co.

In conjunction with the Symposium, the Moab Museum featured a special exhibition, *Summary of Atomic Energy.* Visitors had their choice of two field trips on Sunday, one, a tour of the new alkaline RIP plant at Uranium Reduction Co., the other, a tour of the Arches National Monument and Dead Horse Point, to round out the weekend.



INDUSTRIAL MINERALS NEWSLETTER

Dear Members of IndMD:

On the page facing the April Newsletter was a ballot form on which the membership was given an opportunity to indicate approval or disapproval of a number of changes in the Division Bylaws. The response, while unanimous in approval, was disappointingly light. Chairman Don Emigh and his committee deserve our appreciation for their work to improve the Division Bylaws.

Interesting developments in the use of geothermal steam for power generation are reported in the June 1960 *Raw Materials Survey Newsletter*, published in Portland, Ore. It reports the results of drilling in Oregon, California, and Nevada by Magma Power of Los Angeles. Near Cloverdale, Calif., Pacific Gas and Electric Co. is erecting a 12,500-kw generating plant to utilize thermal steam, completion being scheduled for May 1960. The hot springs and steam vents at Cloverdale were discovered in 1847 and became a nationally known spa in the latter half of the 19th century.

Natural steam is used for power generation in several parts of the world, the best known being in Italy and New Zealand. At Larderello, Italy, the steam temperature varies from 266°F to 446°F and the pressure varies from 71 to 390 psi, depending on the flow rate.

Elsewhere in California, exploration work for asbestos is under way in five areas. Jefferson Lake Sulphur Co. has been active in the serpentine area south of the old copper camp of Copperopolis. It is understood that a 2000-ton mill is under consideration to produce both spinning fiber and seven-group material, which is being utilized in increasing quantities in plastics and building products.

Clute Corp. of Denver is active in an area about ten miles north of Napa.

The U.S. Bureau of Mines has conducted drilling in two areas in Siskiyou County, southwest of Mt. Shasta.

A fourth area under study is the large serpentine mass near the mercury operations of New Idria Mining & Chemical Co. It is reported that a mill is being built near Coalinga which would be the first asbestos producer in this new area.

It is reported that Union Carbide Nuclear Co. is conducting exploratory work in a large serpentine area in the region of the upper San Benito river.

Meanwhile the Canadian asbestos industry continues the search for new deposits. In the Ungaua area, a 3.5-million ton deposit is reported to have been outlined. Additional drilling by Murray Mining Corp. is under way to extend the length and depth of the orebody.

Indications are that Canadian asbestos fiber production will reach a record level in 1960. While production facilities have been increased by 20 pct during the past two years, a recent study forecast that all producers will be operating at, or near, capacity to meet world demand this year. The industry may have another producer at Advocate Mines Ltd., depending upon the evaluation by the participating group, which includes Canadian Johns-Manville Co., Patino of Canada, Amet Corp., and Financier Belge de L'Asbeste-Ciment S.A. The property is located near Baie Verte in the northeastern part of Newfoundland.

New assaults on shaft problems are under way in the rich potash field in southern Saskatchewan. Potash Co. of America has undertaken a program of grouting and repairs after encountering serious water problems in its shaft. International Minerals & Chemical Corp. is reported to be progressing through the difficult Blairmore formation using a European technique called *tubbing*, the employment of cast iron rings as a shaft lining. The rings are said to be 18 ft in diam, 5 ft high, and 18 in. thick. The shaft area is frozen prior to sinking.

Increased fluorspar prices have provided the incentive to resume production at the St. Lawrence Corp. of Newfoundland mine after a shutdown of almost three years.—*R. H. Feierabend.*

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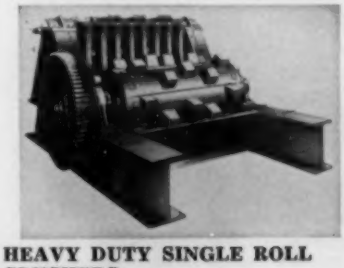

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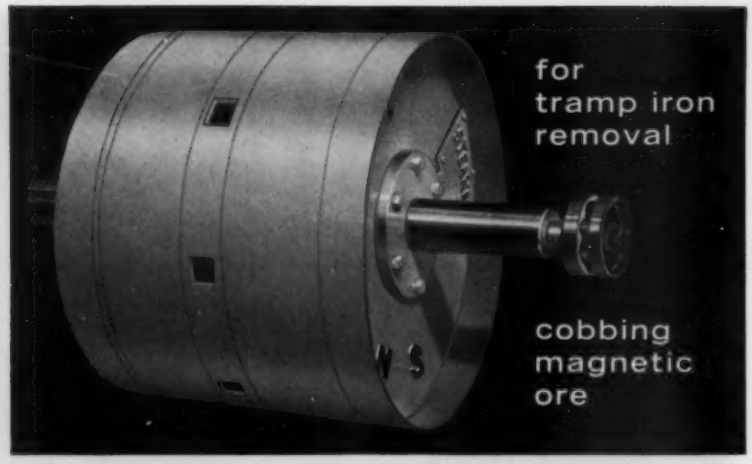

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St. Louis Program

(Continued from page 932)

Stream Pollution: *Clarence W. Klassen*, Chief Sanitary Engineer, Illinois Dept. of Public Health and member of ORSANCO.

The Conference will adjourn at 12:30 p.m. on Friday.

Pan American Congress

The first Pan American Congress on Engineering Education will be held September 12 to 17 in Buenos Aires at the Engineering Center. The morning of the 12th will be devoted to registration and the first session will convene at 3 o'clock that afternoon. In addition to the Congress sessions and committee meetings, an elaborate social program is planned including a tour of the city, two theater parties, a reception, and a banquet. A special program for the ladies has been arranged which includes the social events already mentioned plus a visit to Delta del Parana, shopping, and a tea party.

UPADI Meeting Will Be Held in Buenos Aires

The sixth UPADI Convention will be held September 18 through 22 in Buenos Aires beginning with a fiesta at an estancia outside the city for the Congress on Engineering Education and the UPADI Convention on Sunday, September 18.

Registration begins Monday morning, September 19, at 9:00 in the Engineering Soc. building. The first plenary session begins at 10:30. In the afternoon, starting at 3:00, there will be various committee meetings. The opening session of the convention is scheduled for 8:00 pm, and will be followed by a reception given by the Argentine Engineering Soc.

Tuesday, September 20, committee meetings and round table discussions are scheduled during the day. At 6:00 pm, the board of Directors of UPADI Fund will meet and at 8:00 pm there will be a meeting of the UPADI Board of Directors.

Wednesday, September 21, a visit to the San Nicolas industrial zone is planned for delegates whose committee work is finished. Committee meetings will be held both in the morning and afternoon.

Thursday, September 22, there will be a meeting of the coordinating committee at 10:00 am. The second plenary session will meet at 4:00 pm. The closing session of the Convention will begin at 6:00 pm and a reception follows at 10:00 pm.

A program has also been arranged for the ladies including a tea and fashion show and a tour of the city in addition to the social events scheduled for the Convention.

MBd'ers digest

MINERALS BENEFICIATION DIVISION

The Colorado MBD Section held its annual spring meeting at the Broadmoor Hotel, Colorado Springs, on May 21. The all-day session began with a business meeting in the morning, held in the Copper Room of the Broadmoor Country Club, an adjunct of the hotel. This room, atop the country club, provided a breathtaking setting for the meeting, commanding a view of the golf greens stretching into the rolling hillside, backed by the mountains on the horizon.

One of the main pieces of business to be taken up was determining tentative dates for the spring meeting for the next two years. May 19-21 was chosen for 1961 and May 18-20 for 1962. This will enable those responsible for arrangements to select the most desirable locations and make hotel reservations.

New officers for the year were announced. They are: John W. Barnes, chairman; Clyde V. Johnson, vice chairman; and John Ferguson, secretary-treasurer.

In addition to members of the section, Clifford Hicks, AIME Western Field Secretary, and H. Rush Spedden, national MBD chairman for 1960, attended this meeting.

At the afternoon technical session, following a luncheon break, three papers were presented. A. W. Lankenau, Union Carbide Nuclear, discussed Aerofall grinding mills. J. B. Rosenbaum, the USBM, gave a paper entitled *Recovery of Thorium from Domestic Thorite Ores*, coauthored by S. R. Borrowman. The third paper, *Newer Chemical Developments of Interest to the Mining Industries*, was given by C. J. Lewis, Colorado School of Mines Research Foundation Inc.

The highlight of this session was H. Rush Spedden's report on the third International Mineral Processing Congress, which he attended as the official representative of AIME. This meeting, held in London April 6-9, was under the auspices of the Institute of Mining & Metallurgy. Mr. Spedden, in a brilliant job of condensation, presented abstracts and evaluations of all of the papers delivered during the four-day conference. For those of you who missed this presentation, a detailed report of the conference appeared on pp. 677-677C of the July issue of MINING ENGINEERING, and we commend it to your attention.

In the evening a dinner-dance was held in the hotel proper. This was a purely social occasion without a dinner speaker. Members who stayed on for this found it to be a relaxing end to a well-planned meeting.

NOTICE

Beginning with the fall issue, the MBD Digest will appear in January, April, July, and November.

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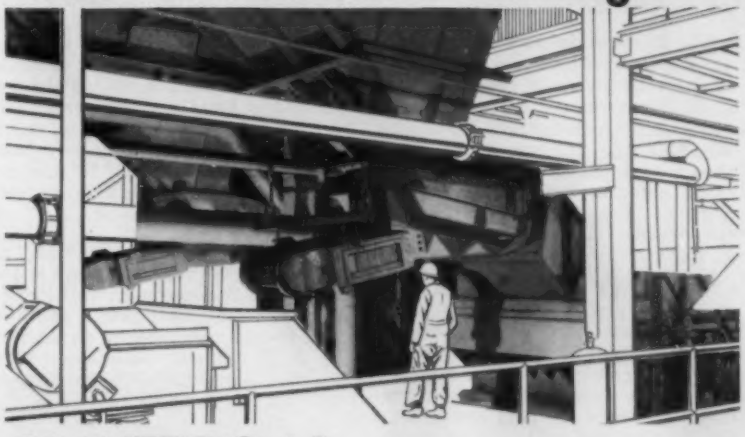

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VIBRATING SCREENS

Around the Sections

• The **Maricopa Subsection** (Arizona Section) met April 7 at the Westward Ho Hotel in Phoenix to hear a talk on Idarado's milling operations at Telluride by Kenneth L. Tatman, who is chief metallurgist and mill superintendent at Idarado Mining Co.

At their May 5 meeting, ladies night, also at the Westward Ho Hotel, the members and their wives heard Edward H. Peplow of the faculty of Arizona State University tell about the history of mining in Arizona and its promise for the future.

• *The Navy in Space and the Conquest of Inner Space* was the subject of the talk given by Lieut. Comdr. C. N. Flitton at the **Bisbee-Douglas Subsection** (Arizona Section) meeting May 25. Colored slides were shown to illustrate the talk and a short question and answer session followed. The meeting was held at the Warren District Country Club in Naco.

• The **Lehigh Valley Section** held its annual dinner dance May 27 at the Berkshire Country Club in Reading, Pa. Robert W. Sleeman, Section chairman, presided over the festivities, which were attended by more than 100 members, wives, and guests. An informal gathering for cocktails preceded the buffet dinner.

• **The Colorado Section** held its monthly dinner meeting at the Petroleum Club in Denver on May 19. Harry L. McNeill, vice president of Stearns-Roger Mfg. Co., gave an illustrated talk on the Toquepala project of Southern Peru Copper Corp.

• The student organization at the Mackay School of Mines, University of Nevada, has changed its name from **Crucible Club** to **Student Chapter, AIME.** The newly elected officers, headed by Dennis G. Reith, president, and interested in forming closer ties with the senior organization. The group has been an active one, presenting high-caliber speakers and valuable technical films to its members.

• As a departure from their usual dinner meetings, members of the **Washington, D. C. Section** visited the world's most modern copper refinery on June 7, 1960. Leaving Washington by chartered bus at 9:00 a.m., they were driven to the new Kennecott Refining Corp. installation located south of Baltimore on the Potapsco River. Here blister copper from Chile and from Kennecott operations in the West is refined at the rate of 16,500 tons per month. Following the tour of the plant, the members were guests of Kennecott at a box luncheon.

• The **Central New Mexico Section** held a regular business and technical meeting in Grants on April 30. The program consisted of talks by representatives of Homestake-New Mexico Partners, Kermac Nuclear Fuels Corp., Phillips Petroleum Co., and Homestake-Sapin Partners describing methods used in mining the wet Ambrosia Lake uranium ores. Following the business meeting, members of the WAAIME Ambrosia Lake Section provided dinner for the approximately 200 people who attended the meeting.

• The **Cleveland Section** held its last meeting of the season May 19 at the Cleveland Engineering and Scientific Center. Following cocktails and dinner, the members heard an address by J. J. Gilman, metallurgist, Research Laboratory, General Electric, entitled *Dislocations and Plasticity.*

• William Dunn, a sergeant in the Narcotics Div., City of Tucson, was guest speaker at the **Tuscon Subsection** (Arizona Section) meeting June 8 at the Holiday Inn. Sergeant Dunn discussed the various narcotics in common use among addicts, their source, and the method of transporting them to the U. S. He also told of the methods employed by the peddlers to push dope and gave a general demonstration on how the addict uses the narcotics.

At their meeting on July 13, members of the Subsection saw a film entitled *A Computor Carol—The Story of Computors, Past, Present, and Future,* presented by General Electric. The meeting was also held at the Holiday Inn.

• Senior students of the local high school interested in science and engineering were guests of the **Yavapai Subsection** (Arizona Section) at the May 2 meeting held at the St. Michael Hotel in Prescott. Albert Mendelsohn, retired manager-president of Greene Cananea Copper Co., addressed the members and guests on the subject of qualifications desirable and necessary in young men entering the engineering field and then went on to discuss present and future opportunities in the profession.

• The **Uranium Section** held its monthly meeting June 7 at the M-4 Ranch. Following a Happy Hour and dinner, the members heard a talk by Ray McBrian, research engineer for the Denver & Rio Grande Western RR. There was also a report and discussion of the highly successful symposium held May 6 to 8. For report of this meeting see page 934.

• On May 21 Chicago Pneumatic Tool Co. was host to the **Adirondack Section** at its plant in Utica, N. Y. Members were given a complete tour through the engineering offices, various testing laboratories, manufacturing, and assembly sections. In the evening a dinner meeting was held at the Town House, preceded by a cocktail hour provided by Chicago Pneumatic. Following dinner, a discussion with colored slides was presented on mining and mineral possibilities in the Dominican Republic.

On June 25 the Section toured the garnet operations of the Barton Mines Corp. at North Creek, N. Y. It is the largest producer of garnet, supplying over 90 pct of the North American demand. Since the Section's last visit to the operation several years ago, there have been some important changes in the mill flowsheet which proved interesting to mill men. A dinner meeting was held afterward at the American Tavern in North Creek at which Charlie Dievendorf, the Section delegate, gave his report.

• The **Eastern North Carolina Subsection** (Carolinas Section) held its summer meeting on Saturday, July 23, at Wrightsville Beach, N. C. Motels and beach hotels provided facilities for an ideal family weekend. The business meeting was held at the Marina Restaurant, beginning with cocktails at noon. The luncheon speakers were J. R. LeGrand and R. J. Councill.

• A special joint meeting of the **Montana Section** and the Montana Society of Mining Engineers was held June 21, 1960, on the campus of the Montana School of Mines in Butte. The purpose of this special meeting was to give members of both organizations an opportunity to hear Wil-

liam B. York, maintenance superintendent, Utah smelter, Kennecott Copper Corp., describe the industrial engineering program recently instituted by Kennecott in Utah and some of the results obtained. The program is concerned with production cost control. A stimulating question and answer period followed the talk.

• The **Lehigh Valley Section** held its annual spring dinner meeting April 15 at the Hotel Bethlehem, where members heard A. C. McMorris of Hercules Powder Co. present a talk entitled *Blasting Vibrations-Cause and Effect.* The presentation was accompanied by a film. Prior to the meeting, the executive committee met, at which time they heard a report on the Section's fund-raising campaign for the United Engineering building. To date the pledges exceed the Section's goal by $1453.

• The **Ajo Subsection** of the Arizona Section held its annual dinner meeting with high school students interested in engineering at the Ajo Country Club on April 14. The main address was given by Dean Forrester of the School of Mines, University of Arizona. He explained the engineering course offered at the University. The Dean emeritus, T. G. Chapman, also gave a short talk.

Officers for the coming year were nominated and elected. They are: Frank Denny, chairman; E. T. Seaberg, vice chairman; J. M. Sudler, secretary-treasurer.

The section's last meeting of the current season was its annual picnic held May 12 at Dennison's Picnic Ground. This was a family affair with the ladies in charge of the food.

• Carleton C. Long, president of the Metallurgical Society, AIME, and director of research of St. Joseph Lead Co., addressed the **Montana Section** at its regular monthly meeting May 2 at the Montana School of Mines in Butte. The title of his talk was *Cooperative Research by Metal Trade Associations.*

• Joseph L. Gillson, AIME president, and Clifford J. Hicks, western field secretary of AIME, were guests at the April 18 meeting of the **North Pacific Section.** Mr. Gillson showed colored slides and discussed archaeological sites in Mexico. He also reported on AIME national membership and on the progress of the new engineering center. Mr. Hicks reported on his activities.

• **Utah Section** officers for the current year are: Norman Weiss, chairman; Oscar A. Glaeser, first vice chairman; Alvin J. Thuli, second vice chairman; and Warren M. Woodward, secretary-treasurer.

• The **Ore Dressing Division** of the Arizona Section held its annual

(Continued on page 940)

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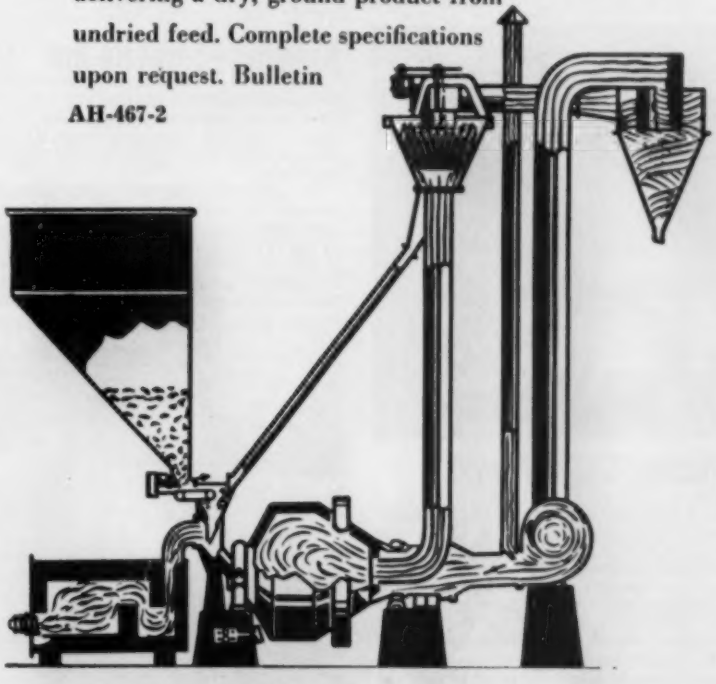

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Cableway-DragScraper Blends, Reclaims Stockpiled Ore

Over a million tons of iron ore may be stockpiled in the new facilities of a South American mining company. The DragScraper permits better blending of the ore and reclaims all stockpiled material that does not flow by gravity into two 3000-ltph. tunnel conveyors.

The 10-yd. Dragscraper is suspended from a carriage traveling on a track cable between two self-supporting towers. These travel on tracks paralleling the storage area. Despite the size of the Sauerman installation, it may be controlled by one man.

(Condensed from a forthcoming Sauerman News)

Efficient Slag Removal

A 4-yd. Sauerman DragScraper machine is incorporated in the waste slag disposal system of a large copper smelting operation. The slag is flumed into two dewatering tanks separated by a common wall. After a tank is drained, the slag is reclaimed by the DragScraper to a hopper at the head end. The DragScraper is remotely operated from a station above the hoist to provide good visual coverage of the installation.

The monorail-trolley assembly at the tail end provides lateral movement of the DragScraper. The monorail spans the tanks, and a Durolite single block on the trolley carries the backhaul cable. Shifting is handled by a motorized winch remotely controlled by the hoist operator.

The DragScraper reclaims to the hopper at about 250 tph. The hopper, in turn, feeds a conveyor belt which carries slag to the disposal area.

(Condensed from Sauerman News No. 155)

Handling Phosphate Ore

Ore concentrate is stockpiled and reclaimed as required to the foot of a bucket elevator by a Sauerman DragScraper Machine at a Southern chemical plant.

A self-propelled tail tower travels around the perimeter of the stockpile. The tower is shifted to change the line of operation. DragScraper haul length is 400 ft. The operator's station for the Sauerman hoist is located above the conveyors to give a clear view of the pile.

(Condensed from Sauerman News No. 151)

MORE NEWS AND INFORMATION

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spring meeting April 9 in Miami, Ariz., as guests of Inspiration Consolidated Copper Co. There was a technical session in the morning, an inspection trip through the operations of Inspiration Consolidated Copper after lunch, and a dinner.

• The **Western Pennsylvania Section of the Woman's Auxiliary of AIME** held a spring party at the Longvue Country Club May 21 for the benefit of the WAAIME scholarship and educational projects. The evening began with a cocktail hour, followed by games, a raffle, and a buffet dinner.

• At its regular meeting March 17, the executive committee of the **Pittsburgh Section** agreed to support the Woman's Auxiliary "Engineers for Tomorrow" program and authorized the expenditure of $200 to support educational programs.

• The **Washington State University Student Chapter** took a trip through the Kaiser Aluminum Trentwood works on February 9th.

On March 29th the Chapter held a meeting in the technology building of the University at which Perry L. Weston, Jr., of Pacific Northwest Alloys, gave a talk on the making of ferroalloys.

• The **Wyoming Mining and Metals Section** held a meeting on February 27 at Casper and Glenrock. In the afternoon the Section toured the coal field and Dave Johnston plant at Glenrock as guests of Pacific Power and Light Co. The evening banquet was held in Casper. H. G. Fisk, director, National Resources Inst., was guest speaker. He gave the delegate's report on the annual convention.

• The **Missouri School of Mines and Metallurgy Student Chapter** was the 1959 winner of the Student Membership's Application Contest. The award was made during the AIME Annual Meeting in New York and in the absence of the student officers of the chapter it was accepted on their behalf by A. W. Schlechten.

• **Southwestern New Mexico Section** held its annual business meeting Feb. 5, 1960, at the Bayard Lions Club Bldg. The following officers were elected: Robert W. Shilling, chairman; Fred E. Johnson, first vice chairman; Howard A. Wilmeth, second vice chairman; David W. Boise, secretary-treasurer; and Howard A. Wilmeth, section delegate. The evening's speaker was Joseph H. Taylor, who discussed *The Outlook for Lead and Zinc.*

At the Section meeting March 4th, Howard Wilmeth reported on the AIME Annual Meeting. C. W. Livingston presented a paper on *Explosive Research Applied to Mine and Quarry Blasting.*

Personals

According to a joint announcement by the St. Joseph Lead Co. and Bethlehem Steel Corp., owners of the mining company, **Robert G. Peets** has been appointed assistant resident manager of the Meramac Mining Co. Mr. Peets has been associated with Bethlehem Steel Co. since his graduation from Michigan College of Mining and Technology in 1938.

Arthur W. Ruff, formerly assistant mine superintendent for Cananea Consolidated Copper Co., has moved to Venezuela to take the job of general superintendent of operations with Orinoco Mining Co.

Richard V. Gaines, who was manager of exploration in Mexico for Dresser Industries Inc., has become affiliated with Perforadora Latina S. A. as director of mineral investigations.

J. H. Vered-Weiss, former mine superintendent with Israel Mining Industries at Tel Aviv, has been transferred to Eilat, where he is chief engineer at the Timna Copper Mines.

C. M. BRINCKERHOFF

H. S. TURNER

The chairman of the board of ACF Industries Inc. recently announced the election of **Charles M. Brinckerhoff** as a director. Mr. Brinckerhoff is president of The Anaconda Co. and a director of many of its subsidiaries.

The National Coal Association announced the appointment of **James R. Garvey** as director of its newly created research department. He was also recently named vice president and director of research of NCA's affiliated organization, Bituminous Coal Research Inc., with which he has been associated since 1946.

Among the officers elected recently at the Industrial Research Institute Inc.'s annual meeting at Virginia Beach, Va., was **Howard S. Turner,** vice president—research and development, Jones & Laughlin Steel Corp. He is vice president and president-elect of the Institute.

R. G. PEETS

H. S. WINGATE

The International Nickel Co. Inc. has made extensive shifts in personnel according to recent announcements: **Henry S. Wingate,** president of The International Nickel Co. of Canada Ltd. since 1954, has been elected chairman of the board and chief officer of the company. **J. Roy Gordon** has been elected president of the company, succeeding Mr. Wingate. Mr. Gordon has been executive vice president since 1957. **Ralph D. Parker,** vice president in charge of Canadian operations, was elected senior vice president of the company. Mr. Wingate succeeds **John F. Thompson,** who retires as chairman after having served the company for 53 years. Dr. Thompson becomes honorary chairman and will continue to serve as chairman of the executive committee.

Howard L. Waldron, formerly professor of mining engineering at the University of North Dakota, has accepted a position as engineer for Barodynamics Inc., Georgetown, Colo. He is employed in the rock mechanics division, which is responsible for research and design for large rock excavations.

Luis A. Nogales, consulting mining engineer with headquarters in Lima, Peru, is currently doing mine examination work in Bolivia.

Dorr-Oliver recently announced the appointment of **Henry W. Hitzrot** to its project department. He will continue to make his headquarters at the company's main office in Stamford, Conn. He had been handling certain administrative matters in the international operations area of the company.

Richard A. Cabell, Albert P. Gagnebin, Ralph H. Waddington, and **James C. Parlee** were elected vice presidents of The International Nickel Co. of Canada Ltd. at the annual organization meeting of the board of directors. **John A. March,** vice president of the company's U. S. subsidiary, was elected to the further office of president of its Huntington Alloy Products Div. **Paul Queneau** was elected technical assistant to the president of The International Nickel Co. of Canada Ltd. Other officers of the Canadian company re-elected at the meeting were: **Lance H. Cooper,** vice president; **William F. Kennedy,** secretary; **F. M. A. Noblet,** treasurer; **Walter A. McCadden,** comptroller; and **H. G. Fales,** assistant to the chairman. **W. J. Gould** was newly elected deputy comptroller and **Dean D. Ramstad,** assistant secretary.

L. E. Grubb has been elected vice president—sales and **E. M. Kline** vice president—operations, Huntington Alloy Products Div. of The International Nickel Co. Inc. **G. B. Dunthorn** was elected divisional comptroller and **W. H. Sweet** assistant divisional comptroller. At the same time **G. K. Crosby** becomes assistant vice president—administration; **J. M. Weldon,** assistant vice president—sales; and **J. E. Carter** assistant vice president—manufacturing.

In other appointments **R. N. Broderick, M. T. Macphee,** and **A. F. Warden** were named assistant comptrollers of The International Nickel Company Inc. Mr. Broderick was also elected assistant comptroller of The International Nickel Co. of Canada Ltd., the parent company. **Kenneth A. DeLonge** was appointed manager, direct sales in the Primary Nickel Department of The International Nickel Co. Inc. Following his transfer to the department in 1958, he became sales manager for the Pittsburgh region.

G. M. Sainsbury has joined the staff of the mining department of the Missouri School of Mines at Rolla. Prior to this, Mr. Sainsbury worked in the engineering department of Consolidated Denison Mine in Spragge, Ont.

James B. Copeland has joined the Sunshine Mining Co. as a mining engineer. He previously worked as stope miner for Bunker Hill Co.

H. L. WALDRON

R. A. CABELL

A. P. GAGNEBIN

L. A. NOGALES

personals

continued

The appointment of **Joseph A. Wiendl** as general manager of sales for Ingersoll-Rand Co. was announced recently. Prior to this new assignment, Mr. Wiendl was assistant general manager of sales. His association with the company dates back to 1941 following his graduation from the Montana School of Mines.

Ted Edwards, veteran underground mining expert, has been named manager of the Mining Equipment Div. for the New York district of The Eimco Corp. In his new position he will assist firms engaged in mining both as a consultant and sales specialist.

Morton I. Dorfan, consulting engineer with Joy Mfg. Co., has been transferred from their industrial division to their western precipitation division. He is also a general consultant in the field of dust smoke and fume control.

Philip L. Platt, previously a geologist with the National Iron Ore Co., has taken a similar position with Mine Management Associates Ltd. in Monrovia, Liberia.

Reserve Mining Co.'s Silver Bay, Minn. division recently announced two changes in key management personnel. **Kenneth M. Haley,** a member of the Reserve staff since 1952, has been advanced to assistant manager of the division. **Donald E. Cooksey,** also with Reserve since 1952 and assistant superintendent of the pelletizing department at Silver Bay since 1955, has been named superintendent of the pelletizing department.

Augustus B. Kinzel, vice president—research, Union Carbide Corp., was awarded the Industrial Research Institute Medal for 1960 at the Institute's annual meeting. The award, which was established in 1945, is given for outstanding accomplishment in leadership or management of industrial research.

Jack F. B. Silman has joined the mining and exploration department of International Minerals & Chemical Corp. as an exploration geologist working from the company's headquarters in Skokie, Ill. He has had nine years of varied experience in mineral exploration programs throughout Canada, including extensive uranium exploration in the Beaverlodge and Blind River areas.

Thomas F. Clemens, formerly mine foreman for the Anaconda Co. in Nevada, has gone to Peru as mine engineer for Marcona Mining Co.

T. EDWARDS

J. A. WIENDL

H. R. Rice, head of the department of mining engineering at the University of Toronto, visited Russia during May and June on an exchange lectureship arranged between the Academy of Sciences of the USSR and the National Research Council of Canada.

The Mining and Metallurgical Society of America has announced that **John L. Mero** has received the first D. C. Jackling Post-Doctoral Fellowship for advanced studies in mining for the academic year 1960-61. This $5000 grant will enable Dr. Mero to continue his studies of deep sea mineral deposits on the ocean floor.

James H. Taylor, formerly mine superintendent at Pulacayo, Bolivia, for the Cia. Huanchaca de Bolivia, has been employed by Frontino Gold Mines Ltd. at La Salada, Segovia, Antioquia, Colombia. Mr. Taylor has worked for the mining industry in the Cripple Creek district of Colorado, the Philippines, Bolivia, Peru, and Ecuador.

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Howard Steven Strouth was recently elected to the board of Standard Magnetite Corp. Mr. Strouth operates the Andacollo Mines in Chile.

Mine Safety Appliances Co. announced recently that **C. M. Donahue** and **E. W. Merry,** vice presidents, have been elected to new posts in the international and the domestic operations of the company. Mr. Donahue becomes president of the M. S. A. International Div. and continues as vice president of the parent company. Mr. Merry becomes executive vice president in charge of domestic operations.

F. Gail Loper has moved from Golden, Colo., to Bartow, Fla., where he will be working for International Minerals & Chemical Co.

William D. Woodbury, who has been on active duty with the U. S. army since April 1958, was separated from active duty at the end of March 1960. He is presently engaged in engineering geology in and around the Oahe Dam site on the Missouri River, Pierre, So. Dakota.

Hyung Sup Choi has left Daihanmoorsan Co. Ltd., Seoul, Korea, to take a position with Kuksan Motors Co. Ltd., also in Seoul.

Ronald H. Longua, formerly authority engineer with U. S. Gypsum Co., is now quarry engineer.

Austin R. Zender, president and chief executive officer of the Bridgeport Brass Co., has accepted the chairmanship of the Metals and Metal Products Div. of the National Fund for Medical Education. Serving with Mr. Zender on the committee are: **Arthur H. Bunker,** chairman, American Metal Climax Inc.; **Alfred C. Butterfield,** president, Vulcan Co.; **C. R. Cox,** president, Kennecott Copper Corp.; **Joseph A. Martino,** president, National Lead Co.; **Henry T. Mudd,** president, Cyprus Mines Corp.; **Fred L. Riggin, Sr.,** chairman and president, Mueller Brass Co.; **T. Spencer Shore,** president, The Eagle-Picher Co.; **William A. Singer,** chairman, Apex Smelting Co.; **Henry S. Wingate,** president, International Nickel Co. Inc.; and **Howard I. Young,** president, American Zinc, Lead and Smelting Co.

The Michigan College of Mining and Technology recently announced the appointment of **James M. Neilson,** professor of geology, as assistant dean of faculty of the college. Dr. Neilson joined the faculty in 1950.

Edward P. Rieder, Jr., has been promoted to the position of Silver Bay Div. industrial engineer, according to a recent announcement from the manager of Reserve Mining Co.'s Silver Bay Div. Mr. Rieder will be in charge of the division's industrial engineering department.

A. R. ZENDER

J. V. S. NORTON

J. V. S. Norton was recently named eastern regional sales manager by Bucyrus-Erie Co. to succeed **F. Leslie Jones,** who retired last December. Norton, who had been assistant sales manager, eastern region, will continue to work out of the New York office.

Quentin G. Whishaw has moved from Nicaragua, where he served as geologist and engineer with La Luz Mines Ltd., to Mexico, where he is engaged in exploration for Union Carbide Ore Co.

William G. Clark, formerly assistant manager for Northern Peru Mining Corp., has moved to Charcas, Mexico, to take a position with Mina Tiro General.

J. V. Thiruvathukal, who came to this country from India in 1958, is presently enrolled at the Institute of Technology, St. Louis University, as a student in geological engineering.

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personals

continued

R. T. Sheppard, previously officer in charge at Iron Range Pty. in Queensland for Broken Hill Pty Ltd., has been transferred to Kooland Island, West Australia, as officer in charge of a large open pit iron ore quarry being constructed by Australian Iron & Steel Pty Ltd., a wholly owned subsidiary of Broken Hill.

The boards of directors of The M. A. Hanna Co. and The Hanna Mining Co. each authorized a realignment of executive responsibilities at a recent directors' meeting as follows: **Joseph H. Thompson,** president of M. A. Hanna, was made vice chairman of the board. **Gilbert W. Humphrey** was elected president and chief executive officer of M. A. Hanna. He was formerly president of Hanna Mining and an M. A. Hanna vice president. **W. A. Marting** became president and chief executive officer of Hanna Mining. He was formerly executive vice president. **R. W. Whitney,** formerly Hanna Mining vice president in charge of mining operations, was named executive vice president.

One of the few women mining engineers in the world, **Maria Caramantzani** *of Athens, Greece, skims off a high grade copper concentrate from a flotation machine at the research laboratory of American Cyanamid Co. in Stamford, Conn. Watching are* **Robert B. Booth,** *left, one of Cyanamid's mining chemicals experts, and* **F. W. Bloecher,** *sales engineer for Cyanamid International, the company's overseas operating division. Miss Caramantzani visited the company in the course of a seven-month tour of the U.S. and Canada, during which she studied new mining techniques. Her trip was made possible by a UN fellowship.*

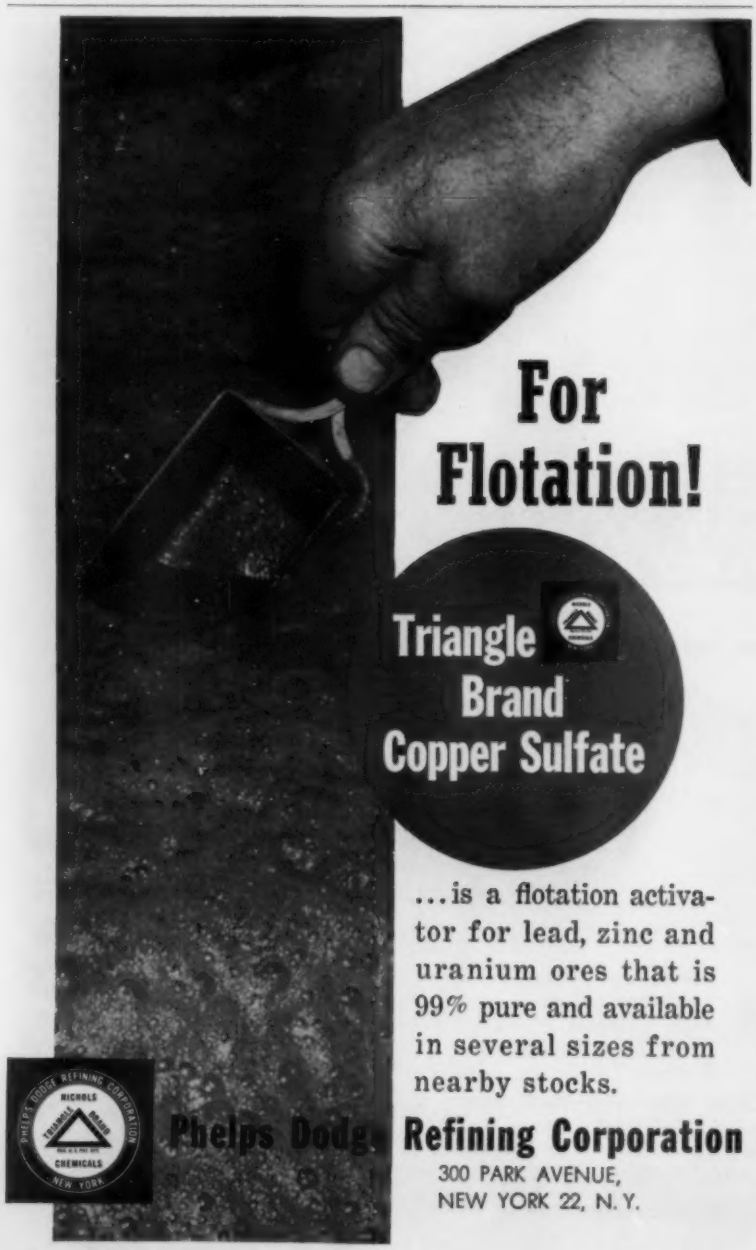
Universal Atlas Cement Div. of U. S. Steel recently announced that **W. O. Lawrence,** assistant vice president, will direct and coordinate the following divisions: purchasing, raw materials and manufacturing research, quality and technical services, and research laboratories. At the same time Mr. Lawrence announced the appointment of **Clayton L. Davis** as director of the quality and technical services division and **Arthur Horen** as director of the raw materials and manufacturing research division. Prior to the appointments, Mr. Davis was technical service director and Mr. Horen assistant director of research.

Clarence W. Six recently retired from Cyprus Mines Corp. after serving as tax accountant and assistant treasurer for 23 years. Upon his return to Pasadena from an extended vacation he will do some private work in mining income taxation.

Wallace J. Cropper, who was a geologist with St. Joseph Lead Co., has joined Cia. Minera Aguilar, S.A. as a geologist, working in Argentina.

Julio Alandia B., formerly assistant general manager for Empresa Minera Quechisla, has joined Empresa Minera Catavi as mine foreman. The change involved a move from La Paz to Catavi, Bolivia.

John H. Snyder, who was employed as a junior engineer for Phelps Dodge Corp. at Morenci, Ariz., has enrolled in the University of Minnesota, where he is working toward his M.S. degree.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C. Jay Parkinson, vice president and general counsel of The Anaconda Co., has been elected to the post of executive vice president and general counsel. He is a director of the company and of many of its subsidiaries. Mr. Parkinson has been employed as a counsel to the company and its subsidiaries and affiliates since 1941. He was named general counsel in 1957 and the following year was elected vice president and general counsel.

James O. Harder, manager of the Black Hills operations of Homestake Mining Co., was principal speaker at the Honors Day Convocation of the South Dakota School of Mines and Technology. During the convocation Mr. Harder was awarded an Honorary Doctor of Engineering degree by his alma mater.

Youngstown Sheet & Tube Co. recently announced the appointment of **Virgil A. Curry** to succeed **Alex (Sandy) Grant** as manager of the company's coal mines in Pennsylvania and West Virginia. Mr. Grant has retired after a lifetime career in the coal mining industry and 15 years with Youngstown. After a trip to Scotland he and his wife plan to make their home in Florida. Mr. Curry was formerly superintendent of the Dehue mine, a position he had held since 1941. **M. M. Fitzwater, Jr.,** production foreman at the Olga mine, succeeds Curry as superintendent at Dehue.

E. P. Chapman, Jr., a partner of Chapman, Wood & Griswold, Albuquerque, N. M., is president of Chapman, Wood & Griswold Ltd., Vancouver, B. C., a newly formed Canadian corporation closely associated with the New Mexican firm and under the same ownership. Mr. Chapman has moved to Vancouver and will work out of the Canadian company's headquarters.

Donald L. Adair, formerly a geologist with Oglebay Norton Co., has joined Cleveland Cliffs Iron Co. as project supervisor.

Roger V. Pierce, consulting engineer of Salt Lake City, spent July in South America visiting Braden Copper Co. and Anaconda Co. operations in Chile, and Toquepala and Cerro de Pasco operations in Peru.

Marion Casper, Alfred D. Wandke, and Roger V. Pierce who formerly operated together in Cuba on their recent visit to mining operations in Mexico.

C. J. PARKINSON

A. G. GILBERT

A. G. Gilbert, formerly general sales manager of the Wilmot Engineering Co., has joined the sales engineering force of McNally Pittsburg Mfg. Corp. He will be working in the coal fields of Pennsylvania, West Virginia, Virginia, and eastern Kentucky.

C. E. McKay, previously chief engineer with Cerro de Pasco Corp. in Peru, has returned to this country to take a job as manager with Utah Dredging Co. working on two river and harbor projects.

Robert B. Schlosser has left Anaconda, where he had been a mine production engineer, to take a position as district mine engineer with Susquehanna-Western Inc.

After three years in Peru as a geologist with Cerro de Pasco Corp., **Major W. Seery** has returned to the U. S. to take a position as senior accountant with Kennecott Copper Corp. at Bountiful, Utah.

Photo - Courtesy, United States Steel Corporation.

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Obituaries

Robert Marion Hardy

An Appreciation By

John Edgar

Robert Marion Hardy (Member 1937) director and former president of Sunshine Mining Co., died at his home in Yakima, Wash., on Sunday, Feb. 21, 1960, ending a distinguished career in engineering, contracting, banking, and mining.

Mr. Hardy was born in Lind Grove, La., Feb. 3, 1883, attended Louisiana Polytechnic Institute and graduated from Louisiana State University, with a degree in civil engineering, in 1903. He came West in 1906 and was employed for a brief time as a mining engineer in Placerville, Calif. Most of his engineering career, however, was spent in railroad and highway construction, first in Louisiana, then Alaska, and finally in Washington.

In 1910 he moved to Yakima, Wash., as division engineer for the Washington State Highway Dept. and a year later established his own general construction business in which he continued for some 12 years. It was during the latter years in the construction business that he became interested in banking.

From the early '20's until he withdrew from banking in 1936 in order to devote his full time to Sunshine Mining Co., Mr. Hardy was president and director of a number of central Washington banking institutions and became vice president and director of the National Bank of Commerce of Seattle and manager of the Yakima Branch, when his banking interests were sold to that institution. During his active banking career he served a term as president of the Washington Bankers Assn. and for three years was a member of the executive council of the American Bankers Assn.

In 1934, Mr. Hardy entered the fourth phase of his distinguished career when he was elected president and director of Sunshine Mining Co., which was to grow, during his presidency, from a struggling, little-known mine in the Coeur d'Alene mining district of Idaho to the largest single silver producer in the U. S. and, at times, in the world. As an indication of the esteem in which he was held by the mining profession, he served three terms as chairman of the Board of Governors of the Western Div. of the American Mining Congress and also served as a member of the War Production Board in Washington, D. C., during World War II. However, it is for his untiring efforts on behalf of silver that he will be best remembered and for which the entire mining industry owes him a debt of gratitude.

Charles F. Deiss (Member 1949), chairman of the Dept. of Geology, Indiana University, and state geologist, died in June 1959. He had held these positions since September 1945. Mr. Deiss was born in Covington, Ky., Mar. 18, 1903. He received his A.B. from Miami University and his Ph.D. from the University of Michigan. From 1928 to 1942 he pursued his teaching career at Montana State University. During part of that time, 1930 to 1936, he acted as field geologist for the Montana State Bureau of Mines and from 1940 to 1942 was assistant geologist, USGS. During World War II, 1942 to 1945 he was a geologist with USGS in charge of exploration for dolomite in the West.

C. G. Dresser (Member 1958) died in September 1959 in Tacoma, Wash., where he had a consulting engineering business. Mr. Dresser was born in Tillsonburg, Ont., on Dec. 21, 1880. He received his B.S. in mining engineering from the University of Utah in 1904 and took graduate work at Columbia University. He was active in the mining field from 1906 to 1916. In 1916 he went with St. Louis Smelting & Refining of National Lead where he became design engineer. In 1932 he went to Midwest Carbide Corp. as chief engineer on design and construction, staying there until 1946 when he started his consulting business.

Samuel R. Fox (Member 1947) died recently at the age of 86. He had long specialized in placer mining, with a business of his own in Oakland, Calif. Mr. Fox was born in Muscatine, Iowa, on Nov. 10, 1873. He received a degree in electrical engineering from Purdue University in 1896 and one in mining engineering the following year. In the course of his career he had worked in such places as Alaska, the Philippines, and the Netherlands East Indies.

John Gilbert (Member 1923) died Nov. 24, 1959, at the age of 79. He was a native of Pennsylvania, born in Rydal, Oct. 10, 1880, and attended the University of Pennsylvania. He maintained an office in Philadelphia at the time of his death.

Frederick F. Kett (Member 1919) died suddenly on March 13 at his home in San Mateo, Calif., where he had been living for the past few years. During the course of a long and distinguished career Mr. Kett's activities took him to many parts of the world, among them Chile, Russia, Siberia, Mexico, and Venezuela. He was born in Chicago, Oct. 7, 1882, and there attended Armour Institute (now the Illinois Institute of Technology). In 1899 he enrolled in the Royal School of Mines, London, from which he graduated in 1903. After a varied career working for a number of U. S., European, and British companies, he joined Vanadium Corp. of America in 1935 and remained with them until his retirement as general manager in 1950.

Walter S. Larsh (Member 1915) was killed in a mine accident last year. Mr. Larsh was born in Cheyenne, Wyo., in 1883. He graduated from the Colorado School of Mines in 1904 and went to work for Strattons Independence Ltd. in Victor, Colo. From 1911 to 1915 he worked in Chile. His later years were spent in Nevada.

Frank E. Lathe (Member 1914) died Jan. 15, 1960, in Ottawa, where he had been with the National Research Council since 1925. Mr. Lathe was born in Lacolle, Que., on Mar. 5, 1883. He received his B.A., B. Sc., and M.Sc. from McGill University.

Whitford J. Lee (Member 1949) died last year in Myrtle Beach, S. C., at the age of 70. Mr. Lee was a native of Brooklyn, N. Y. He went to work for The New Jersey Zinc Co. as a clerk in 1906; became general purchasing agent in 1927, a position he held until his retirement. He spent over 45 years with the company.

E. D. Oosthuizen, 39, field engineer in the mining chemical department of South African Cyanamid (Pty) Ltd., a subsidiary of American Cyanamid Co., died in Johannesburg on Dec. 25, 1959, after a long illness. Mr. Oosthuizen was born in Oudtshoorn, Cape Province, Jan. 21, 1920, and was a graduate of Rhodes University at Grahamstown. He joined the Cyanamid staff in April 1956. Prior to that he was associated with Buffelsfontein Gold Mining Co. Ltd. and Stilfontein Gold Mining Co. Ltd.

O. C. Rheinheimer (Member 1939), 63, died Mar. 8, 1960, in Waco, Texas. Mr. Rheinheimer was a native of El Paso and was a graduate of the Texas School of Mines. His professional career was spent in the southwest and Mexico.

R. H. Richards (1946) succumbed to a heart attack on Dec. 20, 1959, at the age of 56. At the time of his death he was with Homestake Mining Co. in Lead, S. D. Just the week before his death he had been elected second vice president of his local section of AIME.

K. C. Richmond (Member 1950) was killed Oct. 23, 1959, when the car in which he was riding struck an unoccupied vehicle standing on the highway outside Nicosia, Cyprus. He had come to Cyprus in November 1957 to take the position of technical assistant to the resident manager of the Cyprus Mines Corp., the company with which he had been associated since 1950. He was born Oct. 6, 1915, in Gulf Port, Miss., and was a graduate of the College of Mines and Metallurgy of the University of Texas.

W. W. Roff (Member 1944), vice president of Whittaker, Clark & Daniels, Inc., died Jan. 16, 1960. He had been associated with the firm since 1918. He was born in Newark, N. J., on Nov. 6, 1902, and was living in West Orange, N. J., at the time of his death.

G. H. Shefelbine (Member 1945) was killed by a falling slab during a routine inspection tour of the Ike Shaft in the Big Indian mining district near Moab on Mar. 8, 1960. Mr. Shefelbine was born at Dorchester, Iowa, Oct. 21, 1912. He received his professional training at the Colorado School of Mines from which he received his degree in mining engineering in 1935. His mining activities took him to South America, Mexico, and much of the western section of the U. S. At the time of his death he was general superintendent of the Hidden Splendor Mining Co.

G. C. Smith (Member 1941) died at the age of 79 on Jan. 20, 1960. Born in Howard Lake, Minn., and a graduate of Amherst College, he spent most of his professional career in Idaho, where he died.

Kenneth A. Spencer (Member 1928), president of The Pittsburg & Midway Coal Mining Co., Kansas City, and a director of the National Coal Association, died Feb. 19, 1960, in Miami Beach, Fla., following a heart attack February 5. Mr. Spencer was born in Columbus, Kansas, on Jan. 25, 1901, and attended the Kansas State Teachers College and the University of Kansas. He was associated with the coal industry throughout his career and was at one time vice president of NCA and chairman of its Atomic Energy Committee.

H. A. Strain (Member 1936), retired director of raw materials, fuel, and power of the Carnegie-Illinois Steel Co., died at his home on Feb. 26, 1960, at the age of 74. A native of Illinois, he began his lifelong career in the steel industry as a clerk with the American Steel & Wire Co. He came to Pittsburg in 1941 to become director of raw materials, fuel, and power. Upon his retirement in 1951 he served as consultant for Fenimore Iron Mines, Ltd., becoming president and, later chairman of the board. After his resignation he served as consultant to a number of other companies.

C. T. Ulrich (Member 1935) died Feb. 28, 1960 at the age of 74 after a long illness. A native New Yorker, he was long associated with Kennecott Copper Corp.

D. G. Vedder (Member 1939) 69, died Dec. 8, 1959, in Los Angeles, where he had long been self-employed in the production of oil and gas. He was born in Denver, Colo., Nov. 27, 1890, and attended the University of California, graduating in 1915. He worked as a geologist for a few years before going into business for himself.

George Wingfield (Member 1953) died Christmas Day, 1959, at the age of 83 in Reno, Nev., thus ending a remarkable mining career. At the age of 21 he was president of the Goldfield Consolidated Mines Co. and other Nevada mines. By 1929 his interests had expanded in many directions, including most of the banks in Nevada. To save these institutions during the depression, Mr. Wingfield spent his fortune. After several lean years he launched upon another successful venture in 1937, as president of the Getchell Mine near Golconda. Mr. Wingfield was born at Fort Smith, Ark.

Necrology

Date Elected	Name	Date of Death
1931	Joseph G. Calverley	Nov. 28, 1959
1917	W. Lorrain Cook	Mar. 30, 1960
1958	C. G. Dresser	September 1959
1956	Walter K. Farst	Unknown
1950	Fred K. Houston	April 13, 1960
1911	R. M. Macauley	April 7, 1960
1944	Burton M. Reynolds	Feb. 8, 1960
1959	Louis M. Wolford	Jan. 6, 1960
1925	E. C. Smith	May 20, 1960

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Society of Mining Engineers of AIME

Total AIME membership on June 30, 1960, was 33,844; in addition 2,511 Student Members were enrolled.

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The Institute desires to extend its privileges to every person to whom it can be of service, but does not desire as members persons who are unqualified. Institute members are urged to review this list as soon as possible and immediately to inform the Secretary's office if names of people are found who are known to be unqualified for AIME membership.

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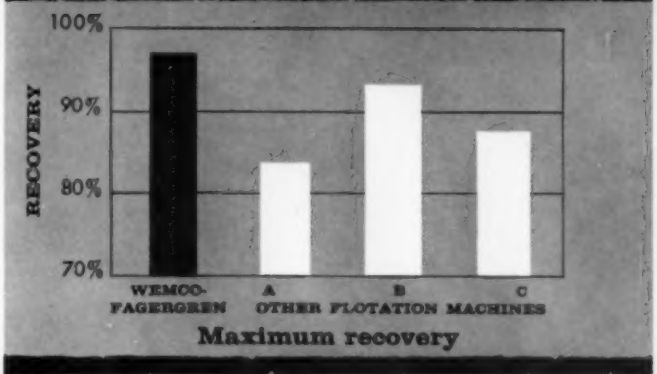

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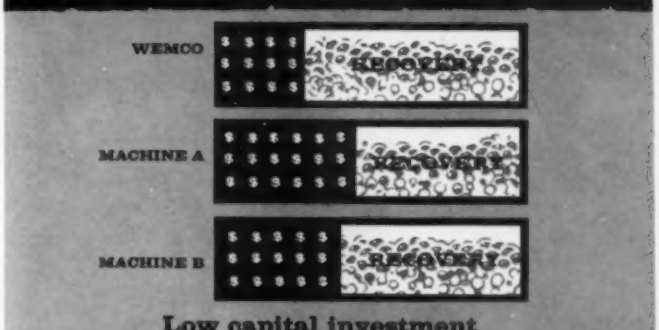

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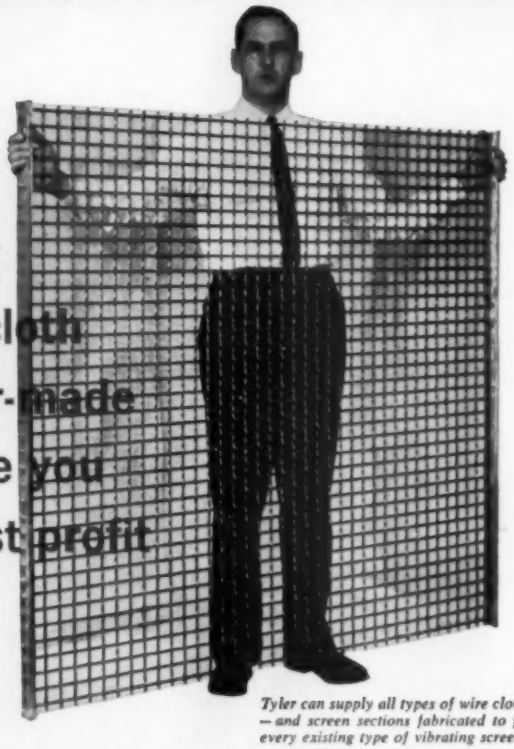

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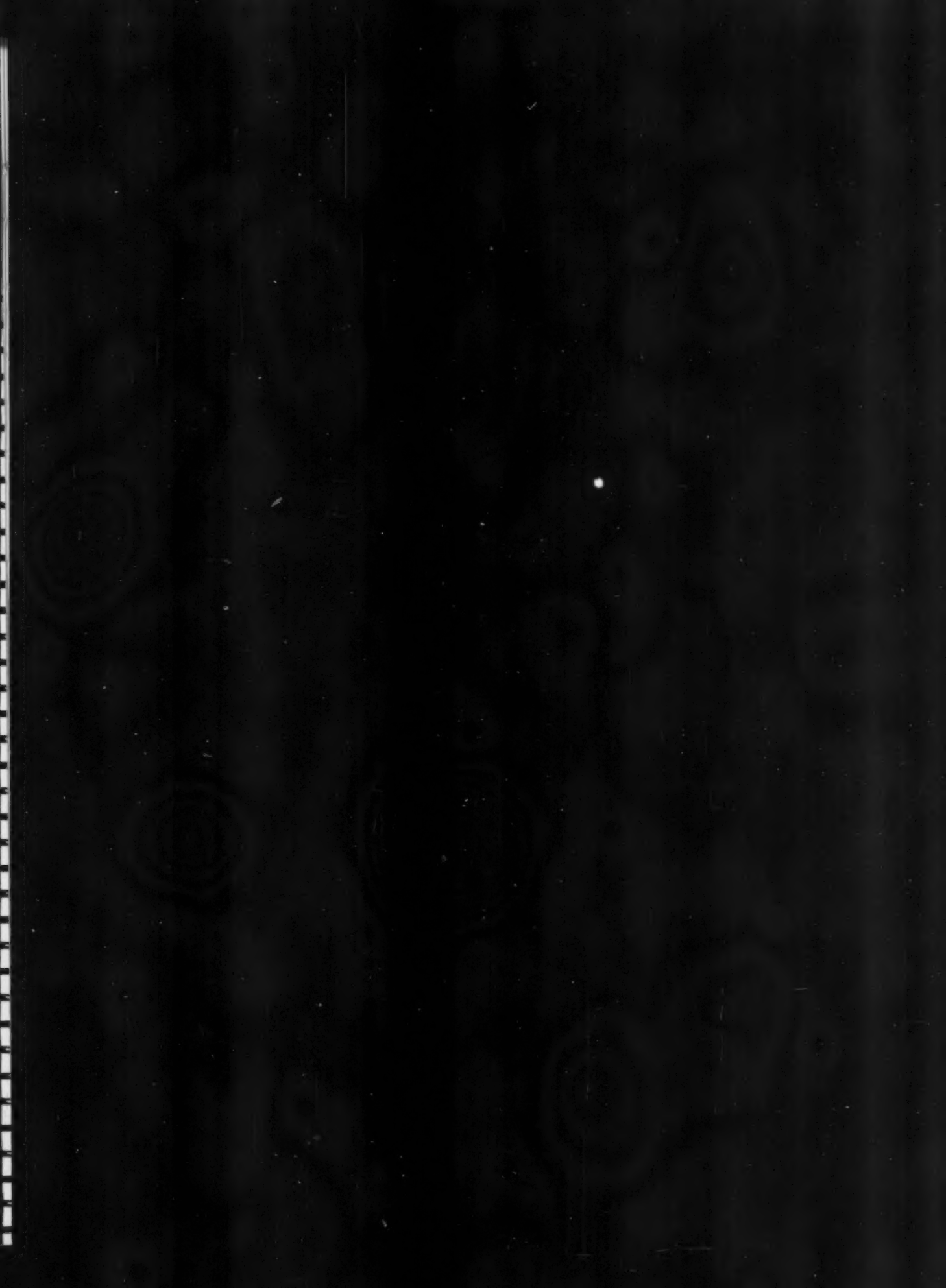
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